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Investigation of the effects of computer-aided animations on conceptual understanding through metaphors: An example of artificial intelligence

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Abstract

In this study, it was aimed to investigate the change in the conceptual understanding of "artificial intelligence". For this purpose, the determination of the metaphors related to the concept of artificial intelligence in the stages before and after watching the artificial intelligence-themed computer-aided animation developed within the scope of the study, and the assessment of change between them constituted the research problem. During the 2021-2022 academic year 39 Information Technologies (IT) teachers and 103 fifth grade students studying in a secondary school in Nilüfer District of Bursa participated in this study. A phenomenological design pattern was adopted throughout the research. In the first stage of the study, many concepts were revealed as a result of the questionnaire applied to determine the concepts that were difficult to teach by IT teachers, and among them the concept of "artificial intelligence" was determined. In the second stage of the study, students were asked to complete the statement "Artificial intelligence is like … because ..." to determine the metaphorical perceptions on the concept of artificial intelligence. Based on the themes obtained from the metaphor results, computer-aided animation on the concept of artificial intelligence was developed by the researchers. After the animation demonstration to students, the metaphorical data collection process was repeated and it was attempted to determine the change in the students' understanding of the concept of artificial intelligence. As a result of the study, although the conceptual categories regarding artificial intelligence generally had similar characteristics, it was observed that the justifications in the post-animation conceptual perceptions were more meaningful.

1. Introduction

Computer-Aided Education (CAE), which took its place in the literature with the inclusion of computers in education, students are provided with environments that will allow them to develop high-level thinking skills and learn by doing and practicing (Demirer, 2005; Jonassen, 2000; Papert, 1996). According to Hannafin and Peck (1989), CAE is defined as the transfer of instructional content and activities via computer. Computer-Aided Instruction (CAI), which has similar features as CAE, is an education method

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in which the computer is used as a learning environment in line with self-learning principles and students can learn at their own learning pace (Kozma, 1991). According to another definition, CAI is expressed as the use of computers in the teaching process in order to teach the subjects and concepts that are intended to be taught to the students and to improve learned behaviors (Yalın, 2012).

Many materials called computer and mobile device-based audio-visual materials such as digital stories, videos, animations, educational software (simulation, animation, educational game, etc.), blog posts, websites, and Powerpoint presentations (Tokmak, 2019) are used within the scope of CAI. Among them, computer-based animation and simulation applications are visualization methods that are commonly used as an alternative tool to other teaching techniques in order to motivate students' learning and maintain their interest while teaching a particular subject (Kalimuthu, 2017; Liu et al., 2021). Burke, Greenbowe and Windschitl (1998) defined educational computer animations as moving visual images that are displayed repeatedly on the computer screen and used to convey abstract information and concepts to students. The animations created using multimedia technologies in the computer environment provide many benefits in the educational software development process and also ensure that the education is effective and efficient (Arıcı and Dalkılıç, 2016). Studies on the effect of using animations in education revealed that students' learning, motivation and academic achievement skills can increase with animation-assisted education (Bülbül, 2009; Daşdemir and Doymuş, 2012; Gana, 2015; Nitin and Abdusselam, 2015).

The intensity of meaning or associations created by an object or thought in the mind are described as the concept (Çepni, 2007; TDK, 2019; Batur and Uygun, 2012). According to Topal Germi (2020), it is not enough to just have knowledge about the concept in order to learn the content, it is necessary to understand the concepts correctly to avoid misconceptions. Computer-aided animations are used to develop a correct understanding of the concepts in education, especially in terms of providing the ability to concretize abstract concepts (Çakıroğlu and Yılmaz, 2017; Kalimuthu, 2017; Kurt; 2018; Putro et al., 2021). It is observed that various studies on teaching with animations in the fields such as chemistry (Pekdağ, 2010; Bayram, Özdemir and Koçak, 2011; Siregar et al. , 2019), science (Chang et al., 2008; Daşdemir and Doymuş, 2016), geography (Yeh et al, 2012; Dikmenli et al., 2018; İmamoğlu, 2018), Turkish lesson (Özcan and Kılıç, 2017), language teaching (Wafi, 2013; Mahmoud El-Bassuony, 2016) and music teaching (Sağer and Ayhan, 2012; Tecimer, 2018) in education were conducted. When it is considered that computer-aided animations are created through computers, the field that needs to be focused is expected to be information technologies.

When the literature on this issue was reviewed, it was observed that the studies mostly focused on computer programming and algorithm development, they were conducted at the higher education (Catrambone and Seay 2002; Végh, 2016) or high school level (Çakıroğlu and Yılmaz, 2017; Jawad et al., 2018; Cevahir, Özdemir and Baturay, 2022), however, there were very few studies on the use of computer-aided animations in information technologies courses at the secondary and primary education levels (Arıcı and Dalkılıç, 2016). This study was conducted in the field of information technologies in order to fill the gap in the literature on the use of computer-aided animations in education. As it is known, Information Technologies and Software Course is taught in 5th and 6th grades within the scope of secondary school curriculum in Turkey and has various learning outcome structures under the units. Among them I.T. 5.1.1.2. "Recognizes the change in information and communication technologies from past to present" is included in the 5th grade 1st unit. There is no clearly stated structure in the curriculum regarding the concept of "artificial intelligence", which is one of the technological developments and has started to be used in all areas of life. Within the framework of the 11th Development Plan issued by the Presidency of the Republic of Turkey in 2019, although the statement "National policy for the production and spread of artificial intelligence technologies will be determined" is present under the heading of Information and Communication Technologies, its reflections on the field of education are still not visible (Republic of Turkey, the

Presidency of Strategy and Budget, 2019). According to Luckin (2017), it is indicated that three basic elements should be added to the education curricula from primary education to adult education so that people can make maximum use of artificial intelligence. These basic elements are having knowledge about artificial intelligence, participating in discussions about what artificial intelligence should do, and having the necessary knowledge to create artificial intelligence systems. Accordingly, it is necessary to design new comprehensive curricula suitable for diversity that will encourage the participation of all students (Pala, 2020). Based on this need, students should be allowed to understand the possibilities, limits, applications and ethical issues of technologies such as artificial intelligence and robotics while providing them with digital literacy skills, and the education system should also be harmonized with the rapidly developing technologies (King, 2019). So, this study focused on the concept of "artificial intelligence" since it is incomprehensive with its abstractness, but it is up-to-date and open to development.

2. Artificial Intelligence

According to the definition of The Oxford English Dictionary, artificial intelligence is “the theory and development of computer systems capable of performing tasks that would normally require human intelligence, such as visual perception, voice recognition, decision making, and translation between languages” (Oxford Reference, 2021). Artificial intelligence is defined as teaching human-specific behaviors such as learning, problem solving, reasoning, and drawing conclusions from past knowledge to a machine or computer (Yılmaz, 2019; Özkaya, 2020). The concept of artificial intelligence, which came to the fore with the possibility that machines designed to help people might have the ability to think in the 1940s, took its place in academic discussions over time, and the term artificial intelligence was mentioned for the first time in 1955 (Kaplan, 2016; Reynoso, 2019). The concept that emerged as artificial intelligence in the 1950s, changed and progressed as machine learning in the 1980s, deep learning in the 2000s, and generalized artificial intelligence since 2010 (Sağıroğlu and Demirezen, 2020).

Different analogies and definitions about artificial intelligence are presented in the literature. For instance, in terms of its abilities such as human intelligence and performance, artificial intelligence is defined as a *tool* capable of using these features (Liebowitz, 2001; Nemati et al., 2002; Zambak, 2014; Flasinki, 2016). It is also observed that artificial intelligence and brain were likened with regard to the solution of many jobs at the same time in a certain way in a certain order (Teng, 2019). According to Bozüyük et al. (2005), some people define artificial intelligence as an electro-mechanical robot that replaces people.

It is observed that artificial intelligence is used in various fields in order to assist people in the recruitment process, to be used as a regular working assistant and chatbot (Aydınalp, 2020), to make social life more livable, to be used as a personal assistant (Kafalı, 2019), and to assist people to stay healthy (Büyükgöze and Dereli, 2019), educational activities (Uçar, 2007) and physicians in making a diagnosis (Karal and Turan, 2021). Although the use of artificial intelligence is increasing day by day and its usage areas have become diversified, it provides many potentials for artificial intelligence-based applications in the field of education (Cengiz, 2019; Karsenti, 2019; Rouhiainen, 2019). Artificial intelligence changes students' learning in and out of school and helps to further automate and improve the tiring and ordinary tasks that teachers must perform outside of their core responsibilities (Joseph, 2019). It is observed that all these current studies in the field of artificial intelligence have a positive effect on educational practices. For instance, while ICAI (Intelligent Computer Assisted Instruction) uses artificial intelligence technology to teach many subjects under different disciplines, UTIFEN (Use of Technology for Mobile Teacher Training in Niger) is described as the greatest gift offered to the field of education in terms of providing a personal learning experience (Harikrishnan and Vitus, 2021).

In addition to the emergence of different learning and teaching processes, studies on artificial intelligence and machine learning are gradually gaining momentum with the aim of understanding and improving new forms of communication, student learning patterns, and learning processes (Güllü, 2021). It should also be taken into account that determining people's perceptions, beliefs and understandings about the concept of

artificial intelligence will be important for the development of the concept. Metaphors are used to determine the meaning created by concepts in people's minds (Lakoff & Johnson, 1990). Metaphors are mental tools that individuals use to understand and interpret complicated concepts (Saban, 2008). According to Shuell (1990), metaphor helps individuals to draw a mental boundary to think about a concept.

A total of 220 teachers, 76 of whom were from the administrative staff, took part in the study attempted to determine the perception of the concept of artificial intelligence at the education level through metaphors (Aktaş, 2011). As a result of this study, it was observed that the most produced metaphors by administrators were "robot, computer, child and assistant", while teachers focused on the metaphors of "robot, computer, child, machine and artificial human". However, in the literature study conducted so far, examining the conceptual understanding of the concept of artificial intelligence at the student level is limited. Furthermore, the use of computer-aided animations in the study in order to affect the understanding of the concept of artificial intelligence is another factor that makes the study important. Therefore, in this study, it was aimed to determine the effect of computer-aided animations on the change in students' conceptual understanding of the concept of artificial intelligence through metaphors. Furthermore, it is considered that the use of the concept of artificial intelligence, which is one of the current technological developments, in this study will provide significant contributions to program developers and educators so that the concept of artificial intelligence could be included in the curricula.

The questions to be answered within the scope of the study are as follows:

1. How do conceptual understandings on artificial intelligence differ before the animation demonstration?
2. How do conceptual understandings on artificial intelligence differ after the animation demonstration?
3. How does the effect of animation demonstration on the conceptual understanding of artificial intelligence differ?

3. **Methodology**

3.1. *Research Design*

A phenomenological research design was used as a qualitative research method in order to determine the perceptions about the concept of artificial intelligence. Studies conducted with a phenomenological design aim to reveal and interpret individual perceptions about a phenomenon (concept, event, etc.) in detail (Merriam, 2013). In this context, the applications were carried out in three stages. In the first stage, Information Technology teachers were asked to identify the concepts throughout the 5th grade Information Technologies and Software Course curriculum and rate them between 1 and 5 according to the difficulty in the teaching process. In the second stage, the metaphor test on artificial intelligence was applied to fifth grade students, and a computer-aided animation that introduces the concept of artificial intelligence was developed within the framework of the conceptual perceptions obtained from the students. In the third stage, the metaphor test on artificial intelligence was applied again after the students watched the animation developed.

3.2. *Animation Development Process*

The ADDIE instructional design model (McGriff, 2000; Kaminski, 2007) was used in the development of the animation that describes the concept of artificial intelligence. This model was selected since it allows easy transition between the steps and is a learner-centered model (Gedikoğlu and Semerci, 2016) as well as being widely used in instructional design (Akkoyunlu, Altun and Soylu, 2008).
Two cycles, the first improvement cycle and the second improvement cycle, were applied in the design process of the animation. The design process was as follows;

1. Selection of the relevant concept: In this stage, within the framework of needs analysis, procedures were carried out regarding which conceptual statement should be based on the research. In this context, it was first aimed to determine the concepts that teachers have difficulty in teaching achievements throughout the Information Technologies and Software curriculum. At this point, 39 Information Technology teachers were asked to rate the difficulty of the concepts on the basis of curriculum and the level of understanding by students between 1-5 on the questionnaire. When the data were evaluated, it was observed that most difficulties were experienced in teaching the concepts as bit, byte, binary, octal and hexadecimal number systems (35.89%), algorithm (39.10%), original project development (40.33%) and webpage styling (CSS) (39.58%). Apart from the concepts included in the questionnaire, teachers were asked to indicate which concepts they had difficulty in teaching. It is noteworthy that the concept of artificial intelligence, which is among computational thinking, internet of things and sensors was remarkable by 35.93%. Within the framework of the results obtained, it was decided to develop an animation for the concept of artificial intelligence due to both its up-to-date status and difficulties in concretization.
2. Creating a scenario: It is necessary to determine the scenario of animation. For this, metaphorical perceptions on artificial intelligence were collected from the students in order to reveal what they liken or formed in their minds. Within the scope of the results obtained, clues about the character to be included in the scenario and the flow content were collected, and the scenario script was created accordingly. Furthermore, expert opinions were used while editing the scenario script. Finally, within the scope of all the arrangements, storyboards were created for the visualization of the story of the scenario.
3. Receiving expert opinions: At this stage, the suitability of the scenario text was examined by two experts on Computer and Instructional Technologies Education. The experts especially drew attention to the level of compatibility of the students by keeping short and interesting. They emphasized that different visuals should be used in order to distinguish robot and artificial intelligence visuals by students. The necessary arrangements were made based on their feedback.
4. Designing animation: The Web 2.0 tool called Animaker, which supports the creation of computer-aided animation, was used to animate the scenario. Animation can be prepared quickly and easily with the ready-made templates offered by this tool. Furthermore, it can also add richness to animations with many characters and shapes it contains. Human voices were used in the speeches of the characters in the developed animation. The multimedia design principles developed by Mayer (2001) were taken into account during the designing process. The animation prepared for this purpose was evaluated by three different field experts using the Multimedia Application Evaluation Rubric developed by İşbulan and et.al. (2020).
5. Receiving expert opinions: After the preparation of the animation, opinions were received from the field experts of Computer Technologies Education (n=2) and Media and Communication (n=1). One of the experts indicated that not only sound but also emphatic words should be given visually in the part where the definition of artificial intelligence in animation is given. All experts indicated that the vocalization should be changed because there is no difference in accentuation and intonation in the vocalization used. Instead of the computer voice real human sound was used for the vocalization in accordance with the received opinions, and the keywords in the concept of artificial intelligence were emphatically displayed on the screen during the definition process.
6. Application and evaluation: After the necessary arrangements were made for the animation prepared, the last metaphor application was carried out with 103 fifth grade students during a 40-minute course session.

3.3. *Study Group*

The study group consisted of 39 teachers working in the field of Information Technologies (IT) in the 2021-2022 academic year and a total of 103 fifth grade students, including 53 male and 50 female at a secondary school in Nilüfer District of Bursa. The participants in the study were determined by the convenience sampling technique that is one of the purposive sampling method (Yıldırım ve Şimşek, 2013). The reason for choosing this technique is that students were studying at the school where one of the authors of the study is teaching. It was required that the students who would participate in the study should not have been informed about artificial intelligence previously.

3.4. *Data Collection Tools*

Two types of data collection tools were used in this study. First, the "Information Technologies Course Concept Teaching Questionnaire" has been developed by researchers to be applied to IT teachers with the aim of determining the concepts that are difficult to teach and difficult for students to concretization within the scope of the Information Technologies and Software (ITS) course curriculum. An attention was paid to ensure that the conceptual statements in the developed questionnaire would be prepared within the framework of each achievement in the ITS course curriculum. The teachers were asked to rate the difficulty of teaching these concepts in a Likert-type format between 1 "lowest" and 5 "highest". Furthermore, an open-ended question was added at the end because they could indicate a different concept that was difficult to teach, apart from the concepts in the questionnaire. The opinions of three IT teachers were received to ensure the content validity of the prepared form. In accordance with the opinions of IT teachers, the concepts of "artificial intelligence" and "machine learning" were added to the prepared concepts. Thus, 41 concepts at the fifth grade level, 46 concepts at the sixth grade level and 26 concepts for different coding platforms were determined. The questionnaire form developed was applied to the IT teachers online.
As the second data collection tool used within the scope of the study, a metaphor determination form was applied to determine the conceptual perceptions of the students on artificial intelligence. Metaphor is the figurative expression of situations or phenomena through analogy (Geçit and Gençer, 2011). In this context, forms containing the statement "Artificial intelligence is like … because …" were distributed to the students, and they were asked to write their opinions on the blank parts on the form. The statement "because" was included to determine students' bases of the metaphorical perceptions regarding the concept of artificial intelligence.

3.5. *Application Process*

Application process was carried out in four stages and the information about these stages is presented below, respectively:

1st Stage: This stage of the study was carried out in the classroom environment. First, students were informed about the study process and data collection forms were given including the written statement "Artificial intelligence is like … because…". Then, the researchers informed students about how to fill out the blank parts in the text on the form. In the meantime, some examples of different concepts were provided to avoid incorrect filling and students were asked to present examples on the concepts they determined. After the necessary information, the students were asked to write their opinions on the concept discussed on the form. In the meantime, a state of silence was ensured in the classroom and attention was paid to prevent students from affecting each other. The applications carried out in each 5th grade branch were completed in a maximum of 15 minutes. Time was given to the students who needed additional time. After the completion of the application, the data were analyzed and animation was developed according to the analysis result.

2nd Stage: At this stage, after the metaphorical preliminary application on the concept of artificial intelligence, the animation design in the computer environment was carried out. At this point, the

procedures of scripting the concept of artificial intelligence was essential. In this process, the data obtained from the metaphor form applied in the first stage were analyzed and the emerging conceptual perceptions were revealed that were effective on shaping the scenario. Animation design was carried out by the authors of the study based on scenario evaluations (Figure-1). Animaker, one of the Web 2.0 based animation development tool was used during the design phase. The animations were used and their technical features were examined by two experts working in both Computer and Instructional Technologies (n=1) and Media Communication (n=1) departments. In accordance with the expert interviews, it was decided that the speeches of the characters in the animation should be natural in the form of human voices. At this point, the speech dialogues of the relevant characters were recorded with a voice recorder and added to the relevant sections in the animation by using the Camtasia program.

Fig. 1: Artificial Intelligence Animation Scenes

3rd Stage: In this stage, it was ensured that the animation designed with the theme of artificial intelligence was watched by the students in the study group and the same metaphor form applied in the first stage was filled out again. Before the animation was shown, the students were provided with the necessary explanations and information about the process. All of the applications in this stage were carried out in the computer laboratory. First, each student was provided with an individual computer opportunity and they watched the animation with the help of headphones (Figure-2).

Fig.2: Computer Lab Setting and Watching Animation by Students

While watching the animation, the students were given the opportunity to watch it for the second time for a better understanding of the subject. Although there was no time limit, the duration of the application did not exceed 15 minutes. Additional time was given to the student who needed time. After it was agreed that the designed animation was watched by each student, the same metaphorical data collection form with blank statements was distributed to the students again and the students were given time to fill in the blanks on the form. The time between the pre and post applications was realized in a period of 2 months.

4th Stage: At this stage, the analysis of the data obtained as a result of the data collection tool after watching the animation was carried out.

3.6. *Analysis of Data*

In this study, the data were obtained with the Information Technologies Course Concept Teaching Questionnaire applied to the teachers and the metaphorical perceptions collected from the students. In the Information Technologies Course Concept Teaching Questionnaire, the items were scored between 1 (lowest) and 5 (highest). Then, the frequencies and percentages of the conceptual statements in each item were calculated.

The data obtained as a result of the metaphors put forward both before and after watching the animation were analyzed by content analysis within the scope of a qualitative approach. In content analysis, it is aimed to reach similar relationships by converting the obtained data into themes (Yıldırım & Şimşek, 2013). The stages developed by Saban (2008) were taken into account in the analysis of the obtained metaphorical data. These stages are (1) coding and sorting, (2) collecting sample metaphorical images, (3) category development, (4) ensuring validity and reliability, and (5) frequency, respectively, and the process followed in each stage is explained below:

1. Coding and Sorting: The metaphors indicated by the students before and after watching the animation and their reasons were coded and numbered to represent the student in each branch. First, the forms that were left blank by the students or in which the section with the statement "because…" was left unfilled were eliminated and excluded from the analysis.
2. Collecting Sample Metaphorical Images: In this stage, the metaphors were sorted alphabetically again after the forms extracted in the previous stage. The raw data were revised with the subject of metaphor and its logical reason. A list of sample metaphorical image was created by choosing the documents that best represented the metaphorical perceptions (Table 1-2). In this way, it was aimed to ensure the validity of the comments. Participant names are represented by abbreviations as S_1, S_2 ….
3. Category Development: In this stage, students' understanding of the concept of artificial intelligence was analyzed. To this end, the relationship between the subject of metaphor and its logical reason was examined. The metaphors with common features were categorized under a specific conceptual theme by performing the content analysis. In conclusion, the categories of *human*, *a mechanism capable of making decisions*, *robot* and *assistance* were determined jointly before and after the animation demonstration. 4 different conceptual categories consisting of *tool for learning*, *technological tool*, *science and plant* were determined before the animation demonstration, and 3 different categories consisting of *tool*, *invention*, and *developing were determined* after the animation demonstration. Thus, a total of 8 conceptual categories, including 8 categories before the animation demonstration and 7 categories after the animation demonstration, were created.
4. Ensuring Validity and Reliability: The data collection and analysis processes are explained under the application process as above. An example to represent each category is provided in the results section and all researchers were included during the data analysis process. The researchers performed the analyses first individually and then together. At this point, consensus and dissensus

among researchers were determined by using Miles and Huberman's (1994) Reliability=Consensus/(Consensus+Dissensus) formula. Accordingly, the reliability of the study was found to be 98%. During the category development stage, a consensus could not be reached among the researchers only in the category of "superhuman being". After the discussion among the researchers, they agreed to add the concept to the category of *a mechanism capable of making decisions.*

5. Quantitative Data Analysis: All metaphorical data obtained were calculated as frequency and percentage.

3.7. *Limitations of the Study*

This study is limited to secondary school students in an educational institution with the animation prepared by the researchers. An attempt to explain artificial intelligence with animation rather than showing a live example of it can also be considered as the limitation of the study. None of the participants had previously been informed on artificial intelligence. Their lack of education constitutes the delimitation of the study.

3.8. *Ethics Disclosure*

The compliance of the study with ethical principles was evaluated by Social and Human Sciences Ethics Committee of University of Bursa Uludağ and granted the ethical approval to the present study (numbered 2022/1, dated 28/01/2022) at the meeting Ethics Committee and , and the ethics committee approval was obtained. The participants participated in the study on a voluntary basis by being informed about the aim of the study, the confidentiality of personal information and that their data would not be used outside of the study. Since the participants were under the age of 18, a parent consent form was obtained.

4. **Results**

In this section, the results obtained within the scope of the research questions are presented below under the subheadings.

1. **Results on how the conceptual understanding of artificial intelligence differed before animation demonstration**

Information on the metaphorical perceptions of the students before the animation demonstration on artificial intelligence are presented in Table-1.

Due to the incomplete filling of the metaphors and the presence of different expressions, 27 metaphors were eliminated with a consensus. There were 27 samples that were not evaluated in the metaphor study, and it was discussed through a total of 74 data. In the stage of developing the metaphors, basically the metaphors produced by the participants were separated in terms of their common features regarding the concept of artificial intelligence. In this stage, it was examined how artificial intelligence was conceptualized in each metaphorical image based on the "sample metaphor list" created about 74 metaphors. Each metaphorical image produced by the students was analyzed in terms of the relationship between its subject and its source. Then, each metaphorical structure was associated with a certain theme in terms of its perspective on the concept of artificial intelligence (e.g., "*mechanism capable of making decisions*", etc.) and a total of 8 different conceptual categories were created. The features used in collecting 74 metaphors under a certain category are presented in Table-1.

Table 1.
Metaphorical Features on the Concept of Artificial Intelligence Before the Animation Demonstration

Category	f	Metaphor	Sample Reason
Human	27	Human	- Controls himself like a living person.(S_53) - They are very realistic, they can do things that people do. (S_61) - They are very smart and know everything. (S_76)
Mechanism capable of making decisions	4 7	Brain, Intelligence	- Thinks and applies.(S_43) - Able to make decisions like the human brain. (S_66) They can take lessons from their mistakes.(S_96)
Robot	10	Robot	- I liken them to robots because they have intelligence. (S_40) - They are inanimate like robots and can use their minds. (S_79) - They can do what we encoded them. (S_45)
Tool for Learning	7 1	Tool for Learning , Concrete tool	- I use it to learn and get information. (S_22) - Knowledge can be learned from them. (S_81) - They can answer everything. (S_29)
Technological Tool	11	Technological Tool	- It is a digital tool similar to the brain. (S_78) - It is a smart tool included in the phone and computer. (S_10) - It is a technological smart chip. (S_65)
Assistance	3	Assistance	- They assist people. (S_54, S_33, S_62).
Science	2	Science	- Science is the foundation of artificial intelligence.(S_14)
Growing Sprout	2	Plant	- It is a sprout that grows with each passing day.(S_24)

The frequency values of metaphorical perceptions on the concept of artificial intelligence and the categories as a result of their classification are presented in Table 1. When it was examined in the context of emerging metaphors and frequency values, it was determined that artificial intelligence was perceived as *human* (27; 36.48*%), a mechanism capable of making decisions* (11; 14.86%), *technological tool* (11; 14.86%), *robot* (10; 13.51*%*), *tool for learning* (8; 10%) .81), *assistance* (3; 4.05%), and *'science'* and *'growing sprout'* (2.70%), which were repeated twice. When the metaphors of the concept of artificial intelligence put forward in the preliminary application stage were examined in terms of their structural features, it was observed that 27 students perceived artificial intelligence as *human*. The metaphors created by the students in this category can be exemplified "Artificial intelligence is human-like because it can develop or change at any time." (S_13) and "I liken artificial intelligence to *human* beings because they behave very realistically and can do the things that we cannot do" (S_61).

2. Results on how the conceptual understanding of artificial intelligence differed after the animation demonstration

Information on the metaphorical perceptions of the students after the animation demonstration on artificial intelligence is presented in Table 2.

Table 2.
Metaphorical Features on the Concept of Artificial Intelligence After the Animation Demonstration

Categories	f	Metaphor	Sample Reason
Human	4	Human	- Able to think like a human. (S_3)
	2		- Able to analyze like a human.(S_32)
			- They can come to a conclusion quickly like humans. (S_13)
			- They have intelligence, mind and ideas like humans. (S_15)
			They can do anything a human can do. (S_25)
Mechanism capable	2	Being,	- Able to think like a human brain. (S_43)
of making decisions	6	Brain,	- The brain thinks for itself, can control it when a new part
	5	Intelligence	is inserted. (S_96) They are inanimate mind cubes, can be as smart as humans. (S_51)
Tool	4	Information,	- Similar to information, learn new information. (S_90)
	2	Machine,	- Machines contain artificial intelligence. (S_26)
	1	Programmable Tool,	- It is an electronic device made by man. (S_7) Examines
	5	Technological Tool	everything like a camera. (S_74, S_62)
Robot	7	Robot	- It is an all-knowing robot. (S_20)
			- It does what it is told. (S_35) Robots are smart and hardworking. (S_67, S_47)
Invention	1	Invention,	- They can invent and find new inventions.(S_88)
	1	Science,	- Science makes the world more beautiful. (S_17)
	3	Technology	Technology makes life easier.(S_73)
Assistance	3	Assistance,	- They assist people.(S_16) They are the assistants in the
	1	Assistant	future. (S_61)
A Developing	1	Baby,	- A baby can do what you teach him/her. (S_66) It is like a
Mechanism	1	Growing Sprout	growing sprout, it grows as time goes by. (S_24)

When Table 2 is examined, the features of 85 metaphors collected under 7 categories are presented. When the metaphors of the concept of artificial intelligence put forward in the post-application stage were analyzed in terms of their structural features, it was revealed that 42 students perceived artificial intelligence as human. When the metaphors created by the students in this category were examined, perceptions such as "Artificial intelligence is like a *human* because they know everything we can." (S_22) and "I liken artificial intelligence to a *human*, because like robots, it doesn't just do what it knows, it tries to learn it on its own" (S_53) can be exemplified.

When the metaphorical images in Table 2 were examined, they were observed to be *'human'* 42 (49.41%), *'a mechanism capable of making decisions'* 13 (15.29%), *'tool'* 12 (14.11%), *'robot'* 7 (8.23%), ' *invention'* 5 (5.88%), *'assistance'* 4 (4.70%), and *'a developing mechanism'* 2 (2.35%). It was observed that the metaphor of *'human'* was the highest and the metaphor of *'a developing mechanism'* was the lowest. While the human metaphor was 27 before demonstration, it is seen that this rate increased after animation demonstration.

3. How does the conceptual understanding of artificial intelligence differ before and after the animation demonstration?

The descriptions of the metaphor structures related to the effect of animation-aided instruction on the conceptual understanding of the concept of artificial intelligence in the stages before and after the animation demonstration are presented in the tables above. Accordingly, it was determined that there were differences

and also common metaphors in both stages. This change was reflected in the categorical features as well as in the frequencies in similar structures. For instance, it was observed that the *human* metaphor determined in both stages increased from 27 to 42 after the animation demonstration. While the number of students who put forward the metaphor of *a mechanism capable of making decisions* was initially 11, it was 13 after the animation demonstration. It was determined that this situation experienced in the increase in the number of metaphors had a decreasing trend in some metaphorical structures. The fact that the number of students who put forward the metaphor of metaphor was initially 10 and then decreased to 7 after the animation demonstration can be given as an example of this situation. A similar situation was also experienced in the metaphor of tool, and it was observed that the metaphors of tools and technological tools for learning, which were given in two different categories before the animation, were 19 in total and this value decreased to 12 after the animation. When they were evaluated within the context of the common categories, while similar structures were mostly determined in both stages, it was determined that metaphorical structures with a common idea about the mechanism that developed after the animation were formed. The reasons for this increase and decrease are presented together with the reasons in the discussion and conclusion section.

5. Discussion and Conclusions

In this study, it was attempted to determine the change in the conceptual understanding of secondary school 5th grade students on artificial intelligence, before and after watching computer-aided animation, through metaphors. The data obtained as a result of the metaphor analysis were collected in 8 categories before the animation and in 7 categories after the animation. This change on the basis of category is discussed below in the light of the literature.

When the metaphorical perceptions of the students on the concept of artificial intelligence before watching the computer-aided animation on artificial intelligence were examined, the students mostly likened the artificial intelligence to *human*. While the number of students who put forward the human metaphor before the animation demonstration was 27, it was observed that the number of students who indicated this metaphor after watching the animation increased to 42. This change can be described as an expected change in accordance with the aim of the study. Because the purpose of animation, which is designed for students to develop a meaningful and correct conceptual understanding, is for students to describe artificial intelligence as a being close to human. It was observed that the metaphors in the metaphorical structures obtained were in this direction and that the students further likened the artificial intelligence to the human after the animation. It was considered that the increase in human-like analogy of artificial intelligence after the animation was due to the fact that the artificial intelligence in the animation interacted with the main characters by displaying human-specific skills. This situation should be welcomed because when artificial intelligence is examined as a definition, it is expressed as intelligent machines that can act, think and make decisions like humans (Özkaya, 2020). The results obtained in the study are similar to the Aktaş (2021), in which the opinions of administrators and teachers on artificial intelligence were received through metaphors. Accordingly, 6 participants likened artificial intelligence to emotionless human, artificial human and human imitation (Aktaş, 2021).

It was determined that the second category with the intensity of metaphorical perceptions on the concept of artificial intelligence was a tool. While two different categories were created as a technological tool and a learning tool before watching the computer-aided animation on artificial intelligence, these categories were named only as tools after the animation demonstration. Before the animation, 11 metaphors and 8 metaphors were created in the technological tool category and in the learning tool category, respectively. The number of metaphors created in the tool category after the animation was 12. With the artificial intelligence in the animation, which was shown to the students, the characters in the animation could easily handle their jobs and get information from artificial intelligence. Therefore, it was considered that students likened artificial intelligence to a smart and technological tool for learning or getting information. The

description of the concept of artificial intelligence as a tool by students may be due to *human* use of technology as a tool and the use of technology in teaching. In his study in which the opinions of administrators and teachers on artificial intelligence were received, Aktaş (2021) reported that artificial intelligence produced metaphors falling into the category of tool by 7 teachers. Since artificial intelligence has capabilities such as human intelligence, mental states, and machine performance that can imitate humans, Zambak (2014) defined artificial intelligence as a tool that can use these features. Similarly, Flasinki (2016), Liebowitz, (2001) and Nemati et al. (2002) indicated that the concept of artificial intelligence was used as a tool in their study.

The perception of the concept of artificial intelligence as *a mechanism capable of making decisions* stands out as another category created jointly before and after watching the animation. While 11 metaphors were created in this category before the animation demonstration, the number of metaphors created after the animation increased to 13. The fact that artificial intelligence has a decision-making structure, is likened to the human brain, and develops itself by learning was a common feature of the metaphors mentioned under the category of "*a mechanism capable of making decisions*". It was considered that students' thinking of artificial intelligence as *a mechanism capable of making decisions* may be due to the fact that it has a structure that can develop according to the information it collects and that it makes decisions by analyzing this information, in other words, by thinking. A similar situation was also observed in the study conducted by Aktaş (2021), and the brain metaphor, which was classified in the category of a developing being, was among the most produced metaphors. In the study of Teng (2019), it was observed that artificial intelligence and the brain were compared with the explanation of solving many tasks at the same time.

When the metaphors related to the concept of artificial intelligence were examined, it was determined that while the metaphor of 'robot' was revealed by 10 people before the animation, there were 7 people after the animation demonstration. It was considered that the reason why students regarded artificial intelligence as a robot may be due to the fact that they could not shape the concept of artificial intelligence concretely. Artificial Intelligence initially evokes something different to individuals. According to Bozüyük and et. al (2005), some people indicated that they animated the concept of artificial intelligence as an electro-mechanical robot that replaces human beings. When the definition of robot in the Britannica dictionary is examined, it is expressed as “the ability of a computer or a computer-controlled robot to perform various activities similar to intelligent living things” (Copeland, 2021). When the metaphorical structures revealed were examined in detail, it was observed that there were similarities with this definition. For instance, the features such as the robot's ability to do what humans do, think and have intelligence were justified by the students. In the study of Aktaş (2021), it was observed that the robot metaphor was the most produced metaphor among administrators and teachers on artificial intelligence. When the study of Çetinbaş and Avcu (2017) on metaphorical perceptions regarding the concept of robotics was examined, it was observed that technology turned into artificial intelligence and artificial intelligence metaphors were included. In that study, while the concept of robotics was considered as artificial intelligence by the students, it was observed that artificial intelligence was attempted to be defined as a robot in this study.

It was determined that the category of *assistance* was another one of the common categories created within the framework of the metaphors on artificial intelligence before and after watching the animation. While 3 metaphors were determined in this category before watching the animation, the number of metaphors created in this category after watching the animation was 4. From this point of view, it can be understood that students considered that artificial intelligence was assistive since it makes our lives easier. Considering that the purpose of artificial intelligence studies is to assist with difficult tasks and to make our lives easier (Bozüyük et al., 2005), the analogies of the students were at an acceptable level. When the literature was reviewed, it was observed that artificial intelligence was used various issues such as assisting people in the recruitment process, being a regular assistant, being used as a chatbot (Aydınalp, 2020), making social life

more livable, being a personal assistant (Kafalı, 2019), and assisting people to stay healthy (Büyükgöze and Dereli, 2019), educational activities (Uçar, 2007) and physicians in making a diagnosis (Karal and Turan, 2021). Considering the scenario in the animation demonstration, it was considered that the fact that artificial intelligence made suggestions by noticing the state of people being sick led to the idea that it was perceived as a beneficial situation. The fact that the student noticed it during the animation demonstration showed that he became conscious about the *assistance* of artificial intelligence.

It was determined that a developing structure was another category in metaphorical perceptions regarding the concept of artificial intelligence. Here, students defined artificial intelligence as a constantly developing and growing element like a sprout. This category, which was found before and after animation, can be associated with a developing being metaphor in the study of Aktaş (2021). In conclusion, students considered artificial intelligence as a developing structure. While artificial intelligence was expressed as a technologically *t* before the animation demonstration, artificial intelligence was expressed as a mechanism that developed both technologically and in terms of learning after the animation demonstration. This indicates that the concept of artificial intelligence was objectified and better understood. Indeed, while artificial intelligence develops technologically and emerges in various types, it also makes more accurate predictions by adding new learnings to what it learns every day.

When all the metaphors obtained before and after the animation were examined, it was observed that common metaphors were formed in both stages. The difference in the distribution of metaphors according to categories was remarkable. The metaphor categories given before the animation, especially the tool for learning and the technological *tool* metaphor, can form a category together. After the animation, these categories were gathered in the tool category and it was observed that the justifications for metaphors were given in more detail.

It is possible to reach some conclusions as a result of this study conducted to determine the metaphorical perception of the students in the stages before and after animation of the concept of artificial intelligence and to reveal the differentiation between them. Based on the metaphorical structures that were revealed, the concept of artificial intelligence was transferred to the students through animation, and a positive and intended change was observed in the students' conceptual understanding of artificial intelligence after the animation demonstration. It was considered that this change was due to the fact that the students had not previously received education on artificial intelligence and did not fully know the concept of artificial intelligence. As a result of the instruction carried out through animation, the definitions of the concept were learned in a shorter time and easily. The fact that the robot and artificial intelligence characters in the animation were given differently led to an increase in metaphors mainly towards human by distinguishing robot and artificial intelligence. It was observed that the justifications made after the animation were mostly written for concretization and consciously.

The main aim of this study, in which the effects of animations on conceptual understandings of artificial intelligence were examined, was to expand students' perspectives on the concept of artificial intelligence and to enable them to develop an understanding of the concept of artificial intelligence. It was determined through metaphorical grounds that it was revealed that the students did not consider the robot and artificial intelligence as different concepts before the animation. It was determined as a result of the metaphorical study that these concepts had different features after watching the animation. Indeed, while the number of students who likened robot before animation was 10, this number decreased to 7 after the animation, which indicated that the animation, which contributed positively to conceptual understanding, also had an effect on eliminating the misconceptions. Based on the themes that emerged as a result of the metaphorical study, it was observed that the students developed a positive and expected understanding, which indicated that animations supported meaningful and positive learning by improving the conceptual understanding.

6. Recommendations

The study group of this study was determined as the 5th grade students. The Information Technologies and Software course curriculum starts from the 5th grade at the secondary education level for the acquisition of basic digital literacy skills, therefore, the 5th grades, the first step, were included in the study. However, since artificial intelligence is an up-to-date and technological development that we encounter in many fields every day, students are introduced to artificial intelligence from a young age. For instance, the characters in the games containing artificial intelligence or the voice assistants on the phones are some of the examples of artificial intelligence that individuals encounter in daily life. Therefore, the concept of artificial intelligence should be mentioned in the education curriculum in younger age groups and children should be provided with technological awareness.

Furthermore, in the animation developed by the researchers within the scope of the study, only the definition of artificial intelligence and the difference between it and the robot were emphasized. However, the concept of artificial intelligence is a comprehensive and deep concept with sub-branches such as machine learning, deep learning, and neural networks. The animation used in the study was designed to be open to development, both with the intro at the beginning and the slogan at the end. Students can also be provided with other sub-concepts related to artificial intelligence by developing animation at higher grades. Researchers also have this view and are making preparations in this direction. The series of animation about artificial intelligence can be prepared and brought into use as a course content, and thus, the teachers who will organize activities for their students about artificial intelligence will also be provided with a different perspective.

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