ORIGINAL ARTICLE

Examining the Learning Outcomes of the 2024 5th Grade Science Curriculum According to the Revised Bloom's Taxonomy and Comparison with Artificial Intelligence

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Abstract: The purpose of this study is to compare the classifications that researchers and artificial intelligence must make in terms of the Cognitive Process Dimension and the Knowledge Dimension of the updated Revised Bloom's Taxonomy in order to analyze the learning outcomes of the 2024 5th Grade Science Curriculum. The document analysis method, a qualitative research design, was employed in this study. 28 learning outcomes of the 2024-redesigned science curriculum for fifth grade were analyzed in this study. Two faculty members with expertise in scientific education first classified these learning outcomes independently, and then they came to a consensus to finish the classification. Artificial intelligence later categorized the learning outcomes according to both the knowledge and cognitive process dimensions. Consequently, both dimentions were used to compare the researchers' categorization with the artificial intelligence's classification. The results showed that the authors and artificial intelligence categorized 18 outcomes in terms of the cognitive process dimension and 22 outcomes in terms of the knowledge dimension in the same dimension. It is evident that artificial intelligence classifies learning outcomes in a manner comparable to that of the authors, but it also classifies learning outcomes that share some similar expressions across several dimensions. It is recommended that professionals in the field verify the analysis of learning outcomes in science curricula and other artificial intelligence studies.

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Introduction

EDUCATION can assist individuals in gaining positive behaviors, information, and abilities, as well as transform them into persons who are well-equipped to detect the value patterns of society. The teaching program or curriculum is one of the tools used in education for this goal (Sözcü and Aydınözü, 2019). Curriculum is the whole program that includes the courses and related content required to improve and specialize in a field or to graduate from a school (TDK, 2025). Curricula use tools like purpose, subject, content, method, and strategy to try to support and guide the person who will execute them. But as time passes, it becomes necessary to alter the curriculum's substance. The curriculum must adapt to the latest advancements and Technologies (Aksoy and Ünsal, 2019). Numerous investigations have been conducted since 2004 to identify curricular shortcomings in our nation. Among these, some programs embrace metacognitive thinking as the fundamental understanding and take a onstructivist approach (Göçen and Kabaran, 2013). A science and technology curriculum was created in 2005, and science curricula were created in 2013 and 2018 based on this idea. In 2024, a new science curriculum was developed and implemented into education within the framework of the Turkey Century Education Model (MEB, 2024a). The Turkey Century Education Model encourages the need for a person's development to be multifaceted, looks closely at education, and takes into account the need of viewing the person and their requirements from a wide angle. The model's primary goals are to take into account the individual as a whole, including all of his or her knowledge, abilities, inclinations, values, attitudes, and behaviors (MEB, 2024b).

There have been various changes in the purpose, content, learning and teaching processes and measurement-evaluation sections of the Science Course Curriculum prepared in different years. One of these changes is the change in the number of learning outcomes at each grade level. While there were 36 outcomes at the 5th grade level in the 2018 Science Course Curriculum, which was most recently in effect (MEB, 2018), this number decreased to 28 outcomes in the 2024 Science Course Curriculum (MEB, 2024a). In addition to the change in the number of learning outcomes, it can be said that the learning outcomes have also undergone changes in terms of the "Cognitive Process Dimension" and the Knowledge Dimension in Revised Bloom's taxonomy. Various sources emphasize that the simplification and reduction of learning outcomes have been positively welcomed by teachers. In a study conducted by Ak and Köse (2024), the opinions of 25 science teachers working in public schools in the 2024-2025 academic year were taken about reducing the number of learning outcomes and simplifying the subjects in the 2024 Science Course Curriculum. The teachers stated that they would not have difficulty completing the curriculum by the end of the year and that

they viewed this change positively considering the students' level of competence.

The 2024 science curriculum, developed within the framework of the Maarif model, aims to foster students' open perceptions of technological change and their awareness of the digital transformation within the scientific world (MEB, 2024a). Based on this understanding, it is crucial for students to be knowledgeable about artificial intelligence, one of today's leading and popular technologies. Artificial intelligence was first put forward by McCarthy in 1956 at a workshop for artificial intelligence at Dartmouth College (Coşkun and Gülleroğlu, 2021). Following this workshop, artificial intelligence programs began to be developed. Artificial intelligence programs named Aziz were developed in 1961, Benzinga in 1963, Eliza in 1965, Bilgin in 1970 and Stajyer in 1979 (Kutlusoy, 2019). In addition to these developments, the first humanoid intelligent robot, WABOT-I, was produced in Japan in 1972 (Acar, 2020). These new discoveries and inventions remained stagnant until the end of the 20th century. In 1997, IBM developed a program called "Deep Blue" and won the match against Garry Kasparov, the world chess champion of the time, by making 200 million moves per second (Artut, 2019). This incident has clearly demonstrated that computers can be better than humans in some respects. The 21st century will be a century in which artificial intelligence will be frequently mentioned. Today, we can see the advancement of artificial intelligence programs as they reach the point where they can provide advice to doctors and as driverless cars are being used in the United States (İnce, 2017).

Today, there are various AI tools and applications. One of these is ChatGPT (Generative Pre-Trained Transformer), a language model application that uses text-based chat content and provides users with the ability to understand and produce language. ChatGPT users can use the program to learn about a topic, write articles, play games, or chat (Ramos, Lin, & Romero, 2023). What sets it apart from previous chat software is that it offers users a variety of topics and advanced texts within seconds (Mhlanga, 2023). ChatGPT examines and consults millions of sources in its database when asked a question, checking for contradictions in the information it obtains. ChatGPT can be used for a variety of purposes, including education and training, problem-solving, password creation, and entertainment (Arif, Munaf, & Ul-Haque, 2023).

The juxtaposition of the terms education and artificial intelligence is relatively new. Looking at studies conducted in this context, we can say that we will hear the association of education and artificial intelligence frequently in the future. It is stated in the literature that ChatGPT is generally preferred under the name of artificial intelligence and that there is some research on it. For example, in a study conducted by Aktay, Gök, and Uzunoğlu (2023), the subject of recycling was taught to 4th grade students who volunteered at a

public school in Turkey for three weeks using an artificial intelligence tool. As a result, students were asked about their thoughts and experiences about the artificial intelligence tool (ChatGPT) with some open-ended questions. t has been observed that students see learning with artificial intelligence as a different experience, that they find learning science this way fun, and that they want it to be taught this way in their other courses. In addition, it was determined in the study that the artificial intelligence tool did not give incorrect answers to the students' questions and answered them quickly and clearly.

In another study conducted by Kutlucan and Seferoğlu (2024), it was aimed to find the positive and negative aspects of the role of the artificial intelligence tool in education through the KEFE analysis. According to the study data, while the effective use of the artificial intelligence tool revealed its strengths for teachers and students and was seen as a successful application, it was determined that there were some deficiencies in the application regarding ethics and plagiarism. Artificial intelligence tools can be used not only in primary and post-primary education but also in pre-school education. In a study conducted by Uğraş (2024), she/he examined the opinions of preschool teachers regarding the use of artificial intelligence tools in preschool education. In the study, it was determined that preschool teachers had both positive and negative opinions about the use of artificial intelligence tools in preschool education. Teachers, who stated that the artificial intelligence tool would be greatly useful for areas such as personalized activities, creative activities, content creation, games and stories, which are the topics they stated positively, also stated that there may be risks such as incorrect learning of information, technological addiction, loss of social cohesion and the organization of content in an age-inappropriate manner.

As can be seen, it is stated in the literature that artificial intelligence applications have positive and negative aspects at every stage. However, the fact that the studies are generally the result of long-term programs and experiences, and that an analysis of learning outcomes rather than opinions about a program implemented and observed during the process has not been made in previous studies, makes this study original and valuable. The method by which learning outcomes will be analyzed is also important. In this respect, the revised version of revised Bloom's taxonomy, one of the fundamental building blocks of educational sciences, constitutes the subject of this research (Keray & Yılmaz, 2012).

According to the taxonomy developed by Bloom in 1956, learning objectives are grouped into three areas. These are: cognitive, affective and psychomotor areas (Bloom, 1956; cited in Coşkun et al., 2025). In the revised century, contemporary society and its consequences have revealed the need for self-renewal and correction in education and training (Demirtaş et al., 2015). In 2001, a revised taxonomy was prepared by Anderson and

her/his team by making some corrections and changes to the taxonomy (Yaralı, 2024). The revised Bloom's taxonomy is grouped under two main headings: the cognitive process dimension and the knowledge dimension. While the cognitive process dimension consists of the steps of remembering, understanding, applying, analyzing, evaluating and creating, the knowledge dimension consists of the steps of factual knowledge, conceptual knowledge, procedural knowledge and metacognitive knowledge (Krathwohl, 2002).

Purpose of the Research

A science curriculum has four fundamental elements: learning outcomes, content, learning- teaching processes, and measurement-evaluation process. While artificial intelligence is used in every aspect of science education today, it can also be used in the organization of these program elements, program development processes, and program evaluation studies. Artificial intelligence tools can be applied to needs analysis, content organization and selection, learning-teaching process design, measurement-evaluation process planning, and learning outcomes classification. In fact, by forecasting present trends and potential future changes, researchers may ensure that program goals are reasonable and achievable by examining a significant number of data throughout the authoring process of learning outcomes (Altın, 2024). In order to do this, the learning outcomes of the science curriculum were examined using artificial intelligence. Therefore, it is also intended to increase its usage in the assessment of science curriculum learning outcomes. It is known that the number of learning outcomes across grade levels has changed with the 2024 Science Curriculum. In comparison to the previous curriculum, we can claim that not only have the quantity of learning outcomes changed, but so have the skills related to verb-denoting word roots inside the learning outcomes. The purpose of this study is to compare the classifications that researchers and artificial intelligence must make in terms of the Cognitive Process Dimension and the Knowledge Dimension of the updated revised Bloom's taxonomy in order to analyze the learning outcomes of the 2024 5th Grade Science Curriculum. For this purpose, answers to the following questions are sought:

1. According to researchers and artificial intelligence, what level of the cognitive process dimensions of the revised Bloom's taxonomy corresponds to the learning outcomes of the 5th Grade Science Curriculum?
2. According to researchers and artificial intelligence, what level of the knowledge dimensions of the revised Bloom's taxonomy corresponds to the learning outcomes of the 5th Grade Science Curriculum?
3. What are the similarities and differences in the analysis of the learning outcomes of the 5th grade science curriculum according to the

revised Bloom's taxonomy, compared with researchers and artificial intelligence?

Methods

The document analysis method, a qualitative research design, was employed in this study. Document analysis is the process of interpreting and analyzing texts and documents in printed or electronic media (Boven, 2009). Both qualitative and quantitative research can benefit from document analysis (Sönmez & Alacapınar, 2016). Document analysis, has several advantages for the research. These include the possibility for the researcher to regularly review the text, its relevance to the text's structure throughout the investigation, and its lack of impact by the researcher (Boven, 2009). In the study, the 2024 science course curriculum and 28 learning outcomes in the program were analyzed according to the revised Bloom's taxonomy by document analysis. Two faculty members with expertise in science education and ChatGPT 4.0, the latest version of the artificial intelligence application ChatGPT, analyzed and categorized these learning outcomes based on the cognitive process and knowledge dimensions of the revised Bloom's taxonomy.

In this study, artificial intelligence was asked to classify the learning outcomes of the 5th grade science curriculum according to the revised Bloom's taxonomy. The process was repeated 5 times to ensure that the AI consistently made the same classification. Since no difference was observed in the classification made by the artificial intelligence, the process was completed after 5 repetitions. The following prompts were used in the artificial intelligence. The prompts were written separately, and the 5th grade learning outcomes were added, and the artificial intelligence was asked to classify them according to the revised Bloom's taxonomy.

1. Prompt: For the cognitive process dimension, "What is the Cognitive Process Dimension (Remembering, Understanding, Applying, Analyzing, Evaluating, Creating) of all the learning outcomes of the 5th grade science curriculum given below, according to the Renewed Bloom Taxonomy?"
2. Prompt: For the knowledge dimension, "What is the Knowledge Dimension (Factual Knowledge, Conceptual Knowledge, Procedural Knowledge, Metacognitive Knowledge) of all the 5th grade science curriculum learning outcomes given below, according to Bloom's revised Taxonomy?"

Sample

The Ministry of National Education's 2024 science curriculum served as the study's source document. The Board of Education website of the Ministry of National Education makes this curriculum publicly accessible. The 28 current 5th-grade science curriculum learning outcomes constitute the research sample. The researchers initially categorized these 28 learning outcomes, and the artificial intelligence tool ChatGPT subsequently classified them based on the knowledge and cognitive process dimensions of the revised Bloom's taxonomy. The data collected was then examined, and the results were displayed as tables and graphs.

Data Analysis

Considering the literature, the researchers classified the curriculum's learning outcomes separately by two authors who are experts in science education, first in terms of the revised Bloom's taxonomy's cognitive process dimension and then in terms of the knowledge dimension. They did this with the aid of definitions found in both the cognitive process and knowledge dimensions of the revised Bloom's taxonomy (RBT) (Anderson et al. 2001). Researchers examined the learning outcomes one by one to make an accurate and complete study in classifying the learning outcomes according to the knowledge and cognitive process dimensions of the revised Bloom's taxonomy.

The learning outcomes in the curriculum consist of phrases that indicate nouns and verbs. While the verb expression in the learning outcome is a cognitive process, the noun expression shows the knowledge dimension (Anderson vd. 2014; cited in Sözcü and Aydınözü, 2019). Subsequently, the researchers collectively compared their classifications. The rationale for each researcher's classification of the learning outcomes was discussed with the other researchers if there were discrepancies. The agreed-upon classification was acknowledged as the researchers' standard classification. The consistency between the classifications made by the researchers for the cognitive process and knowledge dimensions of the achievements made separately was calculated with the formula (Miles Huberman 1996). The researchers' classification of learning outcomes was found to be consistent in 88.9 cases for the Cognitive Process dimension and 89.3 cases for the Knowledge dimension. Consequently, the researchers' classifications might be considered consistent with one another.

The science curriculum's learning objectives were then classified using the ChatGPT artificial intelligence tool according to Bloom's Cognitive Process and Knowledge Dimension, respectively. The learning outcomes were asked to be classified separately in terms of cognitive process dimension and knowledge dimension using the artificial intelligence tool. Following a brief recording of the cognitive process and knowledge dimensions'

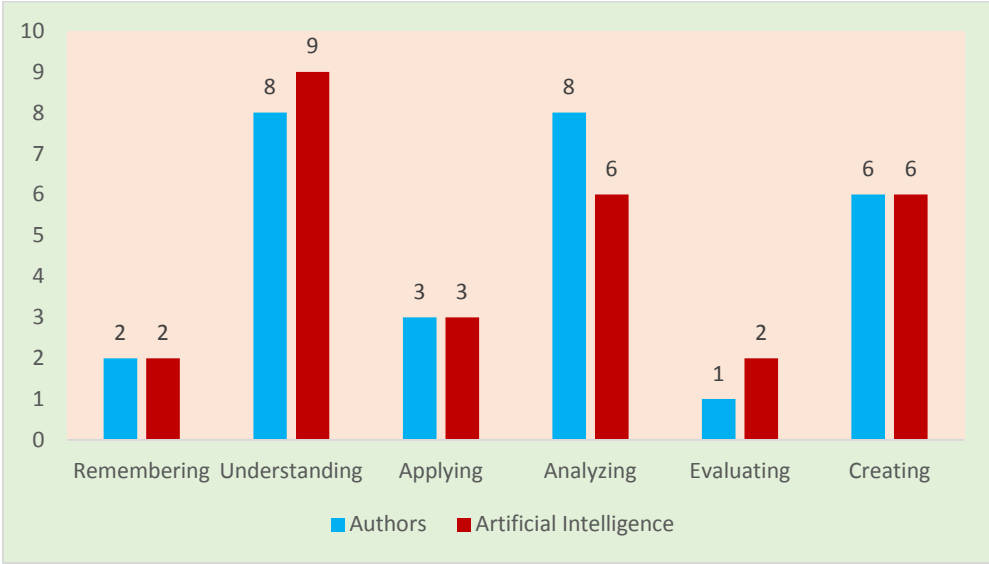

Figure 1. Classification of 5th Grade Science Curriculum Learning Outcomes In Terms of Bloom's Cognitive Process Dimension.

stages into the AI tool, the learning outcomes were loaded, and the cognitive dimension was asked to be classified first. After that, it was instructed to follow the same procedures for the knowledge dimension. To ensure consistent classification, the AI tool was asked to reclassify the cognitive process and knowledge dimensions five times each. The classifications obtained by the AI for each dimension were tabulated, and any discrepancies were included in the most frequently expressed category. The classifications made by researchers and artificial intelligence in terms of the cognitive process dimension and knowledge dimension of the revised Bloom's taxonomy of the learning outcomes of the 2024 5th Grade Science curriculum were combined in the same table and compared. The Miles and Huberman (1996) formula was used to determine the degree of consistency between the classifications made by researchers and artificial intelligence.

Results

The 5th-grade Science curriculum objectives were classified and compared using the authors and an artificial intelligence tool in terms of the Cognitive Process dimension of the revised Bloom's taxonomy. The obtained data are presented in **Figure 1**.

Figure 1 shows the classification of the 5th grade Science curriculum learning outcomes made by the authors and the artificial intelligence in terms of the Cognitive Process Dimension according to revised Bloom's taxonomy.

Table 1. Classification Made by Authors and Artificial Intelligence in Terms of the Cognitive Process Dimension According to Revised Bloom's Taxonomy.

LO	Learning Outcomes	Authors' classificationası	AI's classificationası	Similarities between Authors and AI
LO-1	Ability to Gather information about the Sun's structure and rotational motion	Ap	R	0
LO-2	Ability to Make scientific inferences about the Moon's properties, rotational motion, and winding motion	An	An	1
LO-3	Ability to Create a scientific model representing the phases of the Moon	C	C	1
LO-4	Ability to Create a scientific model representing the relative movements and volumetric sizes of the Sun, Earth and Moon	C	C	1
LO-5	Ability to Define force by its magnitude	R	U	0
LO-6	Ability to Design a dynamometer model using simple tools	C	C	1
LO-7	Ability to Define the gravitational force acting on a mass as weight.	R	U	0
LO-8	Ability to Execute inductive reasoning regarding the effects of friction force in various environments.	An	An	1
LO-9	Ability to Design a scientific model to increase or decrease friction force in daily life	An	An	1
LO-10	Ability to Compare plant and animal cells in terms of their basic parts and properties	U	An	0
LO-11	Ability to Structure the concepts of cell, tissue, organ, system, and organism	An	U	0
LO-12	Ability to Classify the structures of the support and movement systems	U	U	1
LO-13	Ability to Gather information about what needs to be done to ensure the health of the support and movement system	Ap	R	0
LO-14	Ability to Explain through observation that light from a source follows a linear path in all directions.	An	Ap	0
LO-15	Ability to Classify materials according to their light transmittance	U	U	1
LO-16	Ability to Make scientific observations of full shadows	An	Ap	0
LO-17	Ability to Classify substances based on their particulate, porous, and mobile structures	U	U	1
LO-18	Ability to compare the concepts of heat and temperature	U	An	0
LO-19	Ability to Make scientific inferences about heat exchange when liquids with different temperatures are mixed	An	An	1
LO-20	Ability to Predict, based on scientific observation, that matter can change state under the influence of heat	An	E	0
LO-21	Ability to Classify materials in terms of thermal conductivity	U	U	1
LO-22	Ability to Create a model demonstrating thermal insulation	C	C	1
LO-23	Ability to Classify elements in an electrical circuit based on whether they have symbols	U	U	1
LO-24	Ability to Perform experiments based on the electrical circuit diagram drawn	Ap	Ap	1
LO-25	Ability to Formulate hypotheses about the variables that affect the brightness of a light bulb in an electrical circuit.	C	C	1
LO-26	Ability to Classify recyclable and non-recyclable materials in household waste.	U	U	1
LO-27	Ability to Make scientific inferences about the importance of recycling in the efficient use of resources.	An	An	1
LO-28	Ability to Reflect on experiences regarding the feasibility of waste management in the immediate environment.	E	E	1
	Total similarity in classification of authors and AI			18

Not: LO=Learning Outcome; R=Remembering; U=Understanding; Ap=Applying; An.=Analyzing; E=Evaluating; C=Creating; 1=similarity, 0=difference

When **Figure 1** is examined, it is seen that the most gains in the relevant curriculum are related to the Understanding and Analyzing, then the gains are related to the Creating, Applying and Remembering dimensions, and the least gains are related to the Evaluating dimension. It is seen that the classification made by the authors and artificial intelligence regarding the learning outcomes are similar to each other in terms of the Cognitive Process Dimensions. The classification made by the authors and artificial intelligence for each of the learning outcomes of the 5th Grade Science curriculum is given in detail in **Table 1**.

Table 1 shows the comparative classification made by the authors and artificial intelligence in terms of the Cognitive Process dimension according to the revised Bloom's taxonomy of the 5th grade Science curriculum learning outcomes. When the data in the table is examined, the authors classify 18 of the 28 learning outcomes of Artificial Intelligence in the same dimension in terms of Cognitive Process dimension. In 10 learning outcomes, the authors and artificial intelligence made different classifications. The percentage of similarity in classification between AI and authors was calculated using the intercoder reliability formula of Miles & Huberman (1994). The reliability of the similarity between the classification made by the authors and the artificial intelligence for the achievements was calculated as 64.3%.

Classifications were made into different dimensions in each 2 learning outcomes related to "**Ability to gather information…**", "**Ability to define…**" and "**Ability to compare**", and in each 1 learning outcome related to "**Ability to Structurate the concepts…**", "**Ability to explain through observation**", "**Ability to make scientific observations**" and "**Ability to predict, based on scientific observation**".

The authors classify "**Ability to Structurate the concepts**" as part of the "**analyzing**" dimension, while AI classifies it as part of the "**understanding**" dimension. Similarly, the authors classify "**Ability to predict, based on scientific observation**" as part of the "**analyzing**" dimension, while AI classifies it as part of the "**evaluating**" dimension.

The authors classify the phrases "**Ability to Structurate the concepts**" and "**Ability to make scientific observations**" as "**analyzing**", while artificial intelligence is classified as "**applying**" dimension. The authors classify the phrases "**Ability to predict, based on scientific observation**" as "**analyzing**", while artificial intelligence is classified as "**evaluating**" dimension.

In the second part of the study, 5th-grade science curriculum learning outcomes were classified and compared using the authors and the artificial intelligence tool in terms of the Knowledge dimension of the Revised Bloom's taxonomy. The obtained data are presented in **Figure 2**.

Figure 2 shows the classification made by the authors and the artificial intelligence tool in terms of the Knowledge dimension in the revised

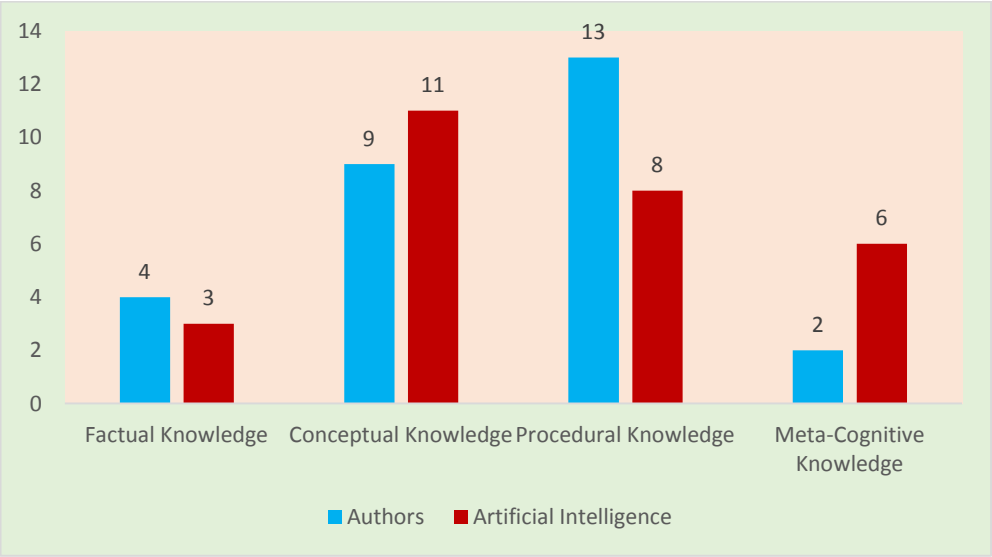

Figure 2. Classification of 5th grade Science course outcomes in terms of Bloom's Knowledge Dimension.

Bloom's taxonomy of the 5th grade Science curriculum learning outcomes. When the table is examined, it can be stated that the 5th grade science curriculum learning outcomes mostly belong to the Procedural and Conceptual knowledge dimensions, followed by the outcomes of the Factual knowledge and Metacognitive knowledge dimensions, respectively.

It is seen that the classification made by the authors and artificial intelligence regarding the learning outcomes is similar to each other in terms of the Knowledge dimension, but there are some differences in terms of the procedural knowledge and metacognitive knowledge dimensions. The classification made by the authors and artificial intelligence for each of the Science curriculum learning outcomes in terms of knowledge dimension is given in **Table 2**.

Table 2 shows the comparison of the classification made by the authors and artificial intelligence in terms of the Knowledge dimension of the revised Bloom's taxonomy of the 5th grade Science curriculum learning outcomes. When the data in the table is examined, it is understood that the authors and artificial intelligence classified 22 of the 28 learning outcomes in the same dimension in terms of knowledge dimension, and they classified 6 learning outcomes differently. The percentage of similarity in classification between AI and authors was calculated using the intercoder reliability formula of Miles & Huberman (1994). The reliability of the similarity between the classification made by the authors and the artificial intelligence for the gains in terms of knowledge dimension was calculated as 78.6%.

Table 2. Classification of Learning Outcomes Made by Authors and Artificial Intelligence in Terms of Knowledge Dimension in the Revised Bloom's Taxonomy.

LO	Learning Outcomes	Authors' classi-fication	AI's classi-fication	Similarities between Authors and AI
LO-1	Ability to Gather information about the Sun's structure and rotational motion	FK	FK	1
LO-2	Ability to Make scientific inferences about the Moon's properties, rotational motion, and winding motion	PK	CK	0
LO-3	Ability to Create a scientific model representing the phases of the Moon	PK	PK	1
LO-4	Ability to Create a scientific model representing the relative movements and volumetric sizes of the Sun, Earth and Moon	PK	PK	1
LO-5	Ability to Define force by its magnitude	FK	FK	1
LO-6	Ability to Design a dynamometer model using simple tools	PK	PK	1
LO-7	Ability to Define the gravitational force acting on a mass as weight.	FK	CK	0
LO-8	Ability to Execute inductive reasoning regarding the effects of friction force in various environments.	MK	MK	1
LO-9	Ability to Design a scientific model to increase or decrease friction force in daily life	PK	PK	1
LO-10	Ability to Compare plant and animal cells in terms of their basic parts and properties	CK	CK	1
LO-11	Ability to Structurate the concepts of cell, tissue, organ, system, and organism	CK	CK	1
LO-12	Ability to Classify the structures of the support and movement systems	CK	CK	1
LO-13	Ability to Gather information about what needs to be done to ensure the health of the support and movement system	FK	FK	1
LO-14	Ability to Explain through observation that light from a source follows a linear path in all directions.	PK	PK	1
LO-15	Ability to Classify materials according to their light transmittance	CK	CK	1
LO-16	Ability to Make scientific observations of full shadows	PK	PK	1
LO-17	Ability to Classify substances based on their particulate, porous, and mobile structures	CK	CK	1
LO-18	Ability to compare the concepts of heat and temperature	CK	CK	1
LO-19	Ability to Make scientific inferences about heat exchange when liquids with different temperatures are mixed	PK	MK	0
LO-20	Ability to Predict, based on scientific observation, that matter can change state under the influence of heat	PK	MK	0
LO-21	Ability to Classify materials in terms of thermal conductivity	CK	CK	1
LO-22	Ability to Create a model demonstrating thermal insulation	PK	PK	1
LO-23	Ability to Classify elements in an electrical circuit based on whether they have symbols	CK	CK	1
LO-24	Ability to Perform experiments based on the electrical circuit diagram drawn	PK	PK	1
LO-25	Ability to Formulate hypotheses about the variables that affect the brightness of a light bulb in an electrical circuit.	PK	MK	0
LO-26	Ability to Classify recyclable and non-recyclable materials in household waste.	CK	CK	1
LO-27	Ability to Make scientific inferences about the importance of recycling in the efficient use of resources.	PK	MK	0
LO-28	Ability to Reflect on experiences regarding the feasibility of waste management in the immediate environment.	MK	MK	1
	Total similarity in classification of authors and AI			22

Not: LO=Learning Outcome; FK=Factual Knowledge; CK=Conceptual Knowledge; PK=Procedural Knowledge MK=Meta-Cognitive Knowledge; 1=similarity, 0=difference

While the expressions "**Ability to make scientific inferences…**" in the learning outcomes were included in the "**Procedural Knowledge**" dimension by the authors, the 2nd outcome was included in the "**Conceptual Knowledge**" dimension, and the 19th and 27th outcomes were included in the "**Metacognitive Knowledge**" dimension by artificial intelligence. It is seen that the expression "**Ability to define…**" is classified by the authors as "**Factual Knowledge**" and by artificial intelligence as "**Conceptual Knowledge**"; the expressions "**Ability to explain through observation…**" and "**Ability to Formulate hypotheses…**" are classified by the authors as "**Procedural Knowledge**" and by artificial intelligence as "**Metacognitive Knowledge**".

Discussion and Conclusion

In this study, the learning outcomes of the 2024 5th Grade Science Curriculum were classified using the Cognitive Process and Knowledge Dimensions of the revised Bloom's Taxonomy using researchers and an artificial intelligence tool. The classifications made by the researchers and the artificial intelligence tool were compared with each other.

The researchers categorized 2 learning outcomes as remembering, 8 as understanding, 3 as applying, 8 as analyzing, 1 as evaluating, and 6 as creating when they applied the Cognitive Process dimension of the revised Bloom's Taxonomy to the learning outcomes of the fifth-grade science curriculum. Artificial intelligence classified 2 learning outcomes as remembering, 9 as understanding, 3 as applying, 6 as analyzing, 2 as evaluating, and 6 as creating. When the 5th grade science curriculum learning outcomes were classified according to the Knowledge dimension of the revised Bloom Taxonomy, the researchers classified 4 outcomes as factual knowledge, 9 outcomes as conceptual knowledge, 13 outcomes as procedural knowledge, and 2 outcomes as metacognitive knowledge. Artificial intelligence, on the other hand, classified 3 outcomes as factual knowledge, 11 outcomes as conceptual knowledge, 8 outcomes as procedural knowledge, and 6 outcomes as metacognitive knowledge. The results show that the classifications made by the researchers and the AI are largely consistent. In the Cognitive Process dimension, 18 of the 28 outcomes were classified in the same level, while in the Knowledge dimension, 22 outcomes were classified in the same level.

When considered in terms of Cognitive Process Dimension, different classifications were made in 10 learning outcomes between artificial intelligence and researchers. However, when these 10 learning outcomes are examined, it is seen that they are gathered under 7 different expressions. It is seen that the same expression is used 2 times in 3 of the 10 outcomes classified differently, and 1 time in 4 of them. According to this result, it can be

stated that the similarity rate in the classification of learning outcomes between artificial intelligence and researchers is higher.

In the Knowledge Dimension, 6 gains were classified in different dimensions between artificial intelligence and researchers. However, when the learning outcomes are examined, it is seen that these 6 achievements are gathered under 4 different expressions. While the expressions "making scientific inferences or being able to make scientific inferences" are found in 3 of the 6 differently classified learning outcomes, the expressions in the other 3 outcomes are mentioned once each. Therefore, it can be stated that the similarity rate in the classification of learning outcomes between artificial intelligence and researchers is higher.

The learning outcomes that differed in the classification made by the researchers and artificial intelligence were examined in terms of the Cognitive process dimension and the Knowledge dimension and interpreted with the support of the literature.

Classifications made regarding the learning outcomes in terms of Cognitive Process Dimension

When the 1st and 13th learning outcomes of the 5th grade science curriculum were examined, it was interpreted that students needed to know some of the information in the learning outcome statement in order to "**ability to gather information**" requested from them and that they should gain the ability to collect different information based on existing information, and this was included in the "**applying**" dimension by the researchers. However, artificial intelligence seems to include the "**ability to gather information**" in the dimension of "**remembering**" by analyzing it in a simpler sense.

When the 5th and 7th learning outcomes of the 5th grade science curriculum are examined, the term "**Ability to define**" is preferred by the authors because it is thought to be compatible with the ability to define some concepts or phenomena while explaining the dimension of "**remembering**" in revised Bloom's taxonomy (Sönmez, 2010). However, artificial intelligence seems to prefer the higher dimension, "**understanding**", based on the way the achievements are expressed. Although the classification between authors and artificial intelligence is different, the ability to define concepts is discussed in the literature in terms of "**remembering**" (Anderson, et al. 2001).

When the 10th and 18th learning outcomes of the 5th grade science curriculum are examined, the expression "comparability" is considered in the dimension of "**understanding**" within the revised Bloom's taxonomy (Turgut & Baykul, 2012; Sönmez, 2010), and the authors classified it as the

dimension of "understanding" because it is thought to be compatible with the ability to compare the relationships or differences of one or more concepts expressed with each other. However, artificial intelligence has preferred the higher dimension of "**analyzing**", based on the way the gains are expressed. Although the classification between authors and artificial intelligence is different, the ability to compare some concepts in this acquisition is preferred in the literature in the "**understanding**" dimension (Anderson, et al. 2001). However, it can be stated that in these learning outcomes, comparisons are made to measure the understandability of different concepts and that there is an achievement in the "**understanding**" dimension.

Considering the interrelationship of more than one concept (Doğanay & Sarı, 2008) in the expression "**Ability to Structurate the concepts of cell, tissue, organ, system, and organism**" expressed in the 11th learning outcome, it was included in the "**analyzing**" dimension by the authors. Artificial intelligence, on the other hand, appears to focus solely on conceptual expression and incorporate it into the "**understanding**" dimension. Considering the scope of this learning outcome, the "**analyzing**" dimension is arguably more appropriate.

The authors preferred these learning outcomes as the "**analyzing**" dimension because the expressions in the 14th and 16th learning outcomes, which include the expressions "**Ability to explain through observation**" and "**Ability to make scientific observations**", are compatible with the "**ability to make observations**" included in the science process skills expressed while explaining the analyzing dimension in revised Bloom's taxonomy. Artificial intelligence, on the other hand, has included the expression of observation ability in the learning outcomes in the "**applying**" dimension. Although the classification of artificial intelligence differs among authors, the term "**ability to make observations**" in these learning outcomes is included within the ability to use the science research methods, and some sources also mention it as an applying dimension (Sönmez, 2010).

Similarly, in the 20th learning outcome, the "**Ability to predict, based on scientific observation…**" was classified in the "***analyzing***" dimension as stated above by the authors, while artificial intelligence was classified in the "***evaluating***" dimension based on the ability to predict as well as observation. Although the authors believe that this learning outcome expresses higher skills than other outcomes that include observation and explanation, they included it in the analyzing dimension because they believe it is not fully compatible with the evaluating dimension in revised Bloom's taxonomy.

Classifications made regarding the learning outcomes in terms of Knowledge Dimension;

Considering that the 2nd, 19th and 27th learning outcomes, which include the expressions "**Ability to make scientific inferences…"** and the expressions "**Ability to predict, based on scientific observation…**" in the 20th learning outcome and "Ability to formulate hypotheses" in the 25th outcome are included in scientific research methods skills (Doğanay & Sarı, 2008), these outcomes were classified by the authors as "***procedural***" knowledge. However, artificial intelligence included the expression "**Ability to make scientific inferences…**" in the 2nd learning outcome in the "***conceptual***" knowledge, while it included the same expressions in the 19th, 20th, 25th and 27th learning outcomes in the "***meta-cognitive***" knowledge. The classification of the learning outcomes explained within the same knowledge dimension in different dimensions by artificial intelligence shows that there may sometimes be incompatibilities in the operations performed by artificial intelligence.

The meta-cognitive knowledge dimension refers to knowledge about cognition and the individual's awareness of and knowledge about his/her own cognition (Doğanay & Sarı, 2008). It is seen that artificial intelligence includes the 19th, 20th, 25th and 27th learning outcomes in the metacognitive knowledge dimension, even though they are not related to metacognition. However, since there is no issue related to cognition and one's own cognitive awareness in these learning outcomes, the authors preferred the "***procedural***" knowledge, which is a sub-dimension.

When the 5th and 7th learning outcomes of the 5th Grade Science Curriculum are examined, the expression "**Ability to define…**" is explained within the factual knowledge dimension, which includes "knowledge of terms, specific details and elements" in the knowledge dimension of revised Bloom's taxonomy (Doğanay & Sarı, 2008), so these outcomes were included in the "***factual***" knowledge dimension by the authors. However, in the 5th learning outcome, where the expression of "**Ability to define…**" is used, artificial intelligence is classified as "***factual***" knowledge in line with the authors, while in the 7th learning outcome, it is classified as "***conceptual***" knowledge. As can be seen from here, it has been concluded that there is incompatibility within some classification operations of artificial intelligence and that there is parallelism in the classification operations performed by the authors. For this reason, although the artificial intelligence has made a classification very close to the classification made by the authors, it is important to check the operations it has performed.

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