

Overcoming challenges in teaching natural history through the cognitive theory of multimedia learning: A case study with preservice teachers

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Highlights

- Preservice teachers reported reconsidering some prior understandings and misconceptions following the documentary-based learning experience.
- Preservice teachers frequently referred to scientific ideas and expressed interest in natural history topics following the documentary-based learning experience.
- Analogies such as the cosmic calendar and the tree of life facilitate understanding of deep time and evolutionary processes.
- Video-based learning promotes conceptual change and helps eliminate some misconceptions among preservice teachers.
- Multimedia-based approaches may provide useful opportunities for engaging with difficult-to-understand content in natural history.

Abstract

Understanding natural processes that have occurred over the 13.8-billion-year history of the universe is challenging for many learners, creating a need for alternative instructional approaches. This study explored preservice teachers' learning experiences and understandings following a video documentary-based learning environment grounded in the Cognitive Theory of Multimedia Learning. The research was conducted using a qualitative case study design with 28 preservice teachers from different academic disciplines. Participants watched the first and second episodes of *Cosmos: A Spacetime Odyssey* and responded to open-ended questions administered through Google Forms. The data were analyzed using content analysis. The findings suggest that participants developed conceptual understandings related to topics such as the structure of the universe, the origin of life, and deep time. Participants' responses also reflected engagement with scientific ideas, reconsideration of some prior understandings, and interest in the subject matter. The cosmic calendar analogy was frequently identified as helpful in making the concept of deep time more comprehensible. Overall, the findings suggest that documentary-based multimedia learning environments grounded in the Cognitive Theory of Multimedia Learning may provide a useful way to support learning about abstract and complex topics in natural history.

Article Info: Research Article

Keywords: *natural history education, cognitive theory of multimedia learning, video documentary-based learning, conceptual understanding, teacher education*

1. Introduction

With the rapid development of technology, learning environments have evolved from traditional teacher-centered approaches toward technology-supported and student-centered practices. The integration of digital technologies into education has transformed the ways learners access information, contributing to the development of more interactive and visually enriched learning environments (Clark & Mayer, 2016). In this context, educational technologies play a significant role in enhancing the quality of learning (Yüzen & Perkmen, 2022; Çaka & Dursun, 2022).

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One of the fundamental challenges in education is the teaching of complex and non-observable concepts. Topics such as the formation of the universe, the origin of life, evolution, and deep time are difficult for learners to comprehend due to their abstract nature and the vast timescales they encompass (Chi, 2009; Öz Aydın, 2015; Avcı et al., 2025; Bedizel et al., 2026). Although various instructional strategies can be designed for teaching these topics, achieving the level of understanding facilitated by audiovisual materials such as video documentaries remains challenging, particularly for concepts involving deep time.

In this regard, video-based learning environments and visual representations have emerged as effective approaches for supporting the learning of complex and non-observable concepts. These approaches facilitate the representation of processes that cannot be directly observed and contribute to learners' development of meaningful understanding (Ainsworth, 2006). Although there are several studies on video-based learning in science education (Dhingra, 2003), research focusing specifically on video-based learning in the context of natural history education is limited, and existing studies tend to emphasize the development of students' observational skills, scientific curiosity, and conceptual understanding (Fink, 1997).

Furthermore, the use of documentaries in learning environments has been shown not only to support the teaching of difficult-to-understand concepts but also to improve students' academic achievement and positively influence their attitudes toward the subject (Uçar & Karakuş, 2017). In this context, the present study aims to explore preservice teachers' understandings and learning experiences related to natural history concepts following documentary-based video learning.

2. Literature

The Cognitive Theory of Multimedia Learning posits that individuals process information through two separate cognitive channels—visual/spatial and verbal/auditory (dual channel)—that these channels have limited capacity (limited capacity), and that meaningful learning occurs through active cognitive processing (active processing) (Mayer, 2002). According to this theory, the integrated and coherent presentation of visual and verbal elements facilitates the comprehension of complex and non-observable concepts and enhances the retention of learning. In this context, video-based learning environments represent one of the practical applications of the Cognitive Theory of Multimedia Learning.

Video-based learning platforms are considered valuable resources for explaining complex and difficult-to-understand concepts (Öncü, 2023; Gürsoy, 2025). By integrating visual and auditory elements, these environments support learners' attention and facilitate the learning process (Koumi, 2006). Research indicates that the use of video enhances learning effectiveness, promotes deep learning, and increases student motivation (Kuchel et al., 2014; Naimah, 2022). Furthermore, video-based learning environments have been shown to increase students' active participation and improve their metacognitive awareness (Koç & Öner, 2023). However, it has also been noted that existing instructional materials are often insufficient for teaching non-observed and process-oriented topics in science education, thereby increasing the need for visualization; consequently, both teachers and students require more visually and aurally enriched learning environments (Nurhayati et al., 2020).

Among the tools used in video-based learning environments, documentary films occupy an important place. Documentaries serve as both sources of information and as instructional materials by presenting real-life phenomena through visual and narrative elements (Sidekli et al., 2013). Their ability to present scientific knowledge through visualization and storytelling enhances student engagement and supports retention of knowledge (Tay & Yıldırım, 2013). In this context, it is emphasized that educational videos combining visual, auditory, and narrative elements increase cognitive engagement and support deeper learning processes (Brame, 2017; Pekdağ, 2010; Zhang et al., 2006).

Throughout history, natural history has been defined in various ways; however, it is generally described as the investigation and description of patterns through the direct observation of the natural world (Nanglu et al., 2023). Fleischner (2005, 2011) defines natural history as a practice guided by accuracy and honesty, deliberately focusing on enhancing human attentiveness and perceptual awareness. Similarly, Gilligan (2009) defines natural history as a field-based science that employs comparative and descriptive methods

to understand and interpret the biotic and abiotic components of the natural world, their interrelationships, and how they evolve over time.

When used as an effective instructional tool, natural history enables students to engage directly with nature, thereby supporting the development of scientific process skills, increasing curiosity, and fostering environmentally conscious individuals (Krupa, 2000). In this context, natural history education not only facilitates the acquisition of theoretical knowledge but also supports individuals in understanding their environment, developing environmental sensitivity, and gaining place-based awareness (Hutchison, 2004). The teaching of natural history and astronomy constitutes an important learning domain that helps students comprehend large-scale temporal frameworks and evaluate natural processes holistically (National Research Council [NRC], 2012). These subjects are critical in enabling individuals to understand their place in the universe, develop environmental awareness, and acquire scientific thinking skills.

However, natural history subjects such as the formation of the universe and the origin of life are inherently difficult to learn due to their non-observable nature and their reliance on deep time, often leading to conceptual difficulties (Trend, 2001; Dodick & Orion, 2003). In particular, students struggle to understand concepts such as the formation of the universe, the origin of life, and humanity's place in the universe, as well as in developing an accurate perception of time related to these processes (Öz Aydın & Şahin, 2023). To support the understanding of such complex and non-observable concepts that occur over deep time, there is a need for learning environments that go beyond traditional instructional methods and incorporate visual and interactive elements. Video- and documentary-based learning environments facilitate the concretization of abstract concepts, ease the learning process, and enable students to evaluate complex scientific processes from a more holistic perspective.

In this context, visualization-based learning environments that facilitate the construction of mental models have been shown to significantly enhance the conceptual understanding of complex and dynamic processes such as plate tectonics (Gobert & Clement, 1999). Particularly in scientific disciplines involving complex and non-observable concepts and deep time, such as natural history and astronomy, visual and documentary-based materials play a critical role in supporting learning and fostering scientific awareness (Impey et al., 2023). Furthermore, the use of analogies is widely recognized as an effective instructional strategy for improving conceptual understanding, as it enables learners to relate unfamiliar scientific concepts to their prior knowledge and supports the development of mental models (Dagher, 1995; Glynn, 2008).

Although previous studies have demonstrated the educational value of multimedia learning environments, instructional videos, and technology-supported learning experiences (Yüzen & Perkmen, 2022; Çaka & Dursun, 2022; Öncü, 2023), relatively little attention has been paid to documentary-based learning in the context of natural history education. In particular, studies exploring how preservice teachers interpret natural history concepts such as the origin of life, the formation of the universe, and deep time through documentary-based learning remain limited. As future educators, preservice teachers play an important role in communicating scientific knowledge and addressing misconceptions related to complex scientific topics. The inclusion of preservice teachers from different teacher education programs also provided an opportunity to explore understandings of natural history concepts across diverse disciplinary backgrounds. Therefore, understanding how they make sense of natural history concepts through documentary-based multimedia learning environments is important. Addressing this gap, the present study explores preservice teachers' understandings and learning experiences following documentary-based learning grounded in the Cognitive Theory of Multimedia Learning. Accordingly, the following research questions were addressed:

1. What are preservice teachers' conceptual understandings of natural history topics following video documentary-based learning?
2. How do preservice teachers describe their reflections, engagement with scientific ideas, and interest in natural history topics during the video documentary-based learning process?
3. How do the analogies used in the video documentary-based learning process support preservice teachers' understanding of deep time and evolutionary processes?

3. Methodology

This section presents detailed information about research design, study group, data collection tools, research procedures, and data analysis. In addition, the measures taken to ensure the validity and reliability of the study are explained.

3.1. Research Model/Design

This study employed a qualitative case study design to examine preservice teachers' understandings and learning experiences related to natural history concepts following a documentary-based video learning experience. Case study design enables an in-depth examination of a specific phenomenon within its real-life context (Yıldırım & Şimşek, 1999).

3.2. Data Collection Tools

In order to obtain more detailed insights into preservice teachers' views, evaluation forms consisting of open-ended questions were developed by the researchers separately for the first and second parts of the documentary and used as the data collection instrument. Open-ended questions allowed participants to express their thoughts freely and enabled the collection of in-depth data. During the development of the questions, the documentary used in the study was reviewed in advance by the researchers, the content areas presented in the documentary were identified, and the questions were constructed accordingly. In this way, preservice teachers' conceptual understandings and perceptions of natural history topics presented in the documentary were examined in detail. The draft questions were reviewed by two experts in biology education. The experts were selected based on their experience in science education research and teacher education. Following their feedback, minor revisions were made to improve the clarity, wording, and content alignment of the questions prior to implementation.

The questions related to the first part of the documentary focused on the structure of the universe and the Earth, the origin of life, interesting aspects of the documentary, misconceptions corrected through the documentary, and the analogies used. The questions related to the second part addressed topics such as artificial selection, natural selection, mutation, the evolution of the eye, and mass extinctions, as well as interesting aspects of the documentary and the analogies used. Responses were collected via Google Forms. The alignment between the content areas presented in the first and second parts of the documentary and the scope of the data collection instrument is presented in Table 1.

Table 1.

Alignment Between Documentary Content Areas and the Scope of Questions

Documentary Content Area	Section	Question Number	Question Statement
Structure and age of the universe	1	S1	What I learned about the structure of the universe and the Earth from the documentary
Origin of life	1	S2	What I learned about the origin of life
Reflections on Prior Understandings	1	S3	The knowledge I changed after watching the documentary
Interest and attention	1, 2	B1-S4; B2-S6	What I found interesting in the documentary
Scientists	1, 2	B1-S5; B2-S7	Scientists mentioned in the documentary
Analogies	1, 2	B1-S6; B2-S8	Explain an analogy used in the documentary
Artificial selection	2	S1	What I learned about artificial selection
Natural selection and evolution	2	S2	What I learned about natural selection
Mutation	2	S3	What I learned about mutation
Evolution	2	S4	What I learned about evolution
Mass extinctions	2	S5	What I learned about mass extinctions

3.3. Sampling or Study Group

The study group consisted of 28 preservice teachers enrolled in teacher education programs at a public university in Türkiye. Participants were selected using convenience sampling, one of the purposive sampling methods. Participation in the study was voluntary, and all preservice teachers who attended the documentary session agreed to participate. The participants were third-year preservice teachers enrolled in teacher education programs during the 2025–2026 academic year. Participants were recruited through a university elective course related to science and natural history topics. Enrollment in the course was voluntary, and all students who attended the documentary-based learning activity and agreed to participate were included in the study. The participants were enrolled in different teacher education programs, including Social Studies Teaching (n = 6), English Language Teaching (n = 4), Elementary Mathematics Teaching (n = 4), Turkish Language and Literature Teaching (n = 4), Preschool Teaching (n = 3), Chemistry Teaching (n = 2), Primary School Teaching (n = 2), Turkish Language Teaching (n = 2), Music Teaching (n = 2), and Biology Teaching (n = 1).

3.4. Data Analysis

The collected data were analyzed using content analysis. Content analysis is a qualitative data analysis method that involves systematically examining data and organizing them into meaningful codes, categories, and themes (Yıldırım & Şimşek, 1999; Miles et al., 2014). Initially, preservice teachers' responses were carefully examined, and meaningful units were identified. The unit of analysis was defined as a meaningful statement or idea expressed in participants' written responses. These units were then coded and grouped into categories based on similarities. Subsequently, categories were organized into broader themes. Frequency values were calculated to support the findings, and participant statements were presented using

codes such as PT (Preservice Teacher). Frequency values represent the number of coded response units identified within each category. Since a single participant response could include more than one meaningful unit, frequency values may exceed the total number of participants.

3.5. *Validity and Reliability*

In order to ensure the validity and reliability of the study, several measures were taken. The data collection instrument was developed in accordance with the content and learning objectives presented in the two episodes of the documentary. To enhance content validity, the questions were reviewed by an expert in science education and revised based on the feedback received. In this context, the content areas for the first episode included the age of the universe, the cosmic calendar analogy, the Milky Way Galaxy, our place in the universe, the origin of life, and scientific thinking; while the second episode included the chemical basis of life, natural selection and evolution, mutation, artificial selection, and the tree of life analogy.

The alignment between the documentary content areas used in the data collection instrument and the themes obtained through content analysis is presented in detail in the findings section. This alignment supports the content validity of the data collection instrument.

During the data analysis process, coding was conducted by the researcher. To enhance consistency in coding, the coding scheme and category structure were reviewed repeatedly throughout the analysis process. In addition, direct quotations from participants were included to support the credibility of the findings, and transparency was ensured by providing a detailed description of all stages of the research process.

3.6. *Research Procedures*

The study was conducted during the 2025–2026 academic year within an elective course attended voluntarily by third-year preservice teachers. To prevent potential bias in the findings, participants were asked whether they had previously watched the documentary *Cosmos: A Spacetime Odyssey*, and it was determined that none of them had prior exposure to the documentary. To actively engage participants in the learning process, they were asked the question, “Would you like to transform the classroom into a cinema environment?” Their responses were taken into consideration, and the learning environment was designed accordingly. Based on participants’ suggestions, the classroom was rearranged by installing blackout curtains, integrating a cinema-style sound system, and allowing participants to bring snacks such as popcorn and beverages. This arrangement aimed to create an engaging and motivating learning environment. In the organized classroom setting, the first and second episodes of the documentary *Cosmos: A Spacetime Odyssey* (2014) were shown, with a 15-minute break between the episodes. The documentary was selected because it addresses key natural history concepts relevant to the study, including the age of the universe, the origin of life, evolution, and deep time, while presenting these topics through rich visualizations and narrative explanations. The first episode, which lasts approximately 45 minutes, includes topics such as the age of the universe, the cosmic calendar analogy, the story of Bruno, the Milky Way Galaxy, our place in the universe, and the importance of scientific thinking and inquiry. The cosmic calendar analogy compresses the 13.8-billion-year history of the universe into a single calendar year, helping learners conceptualize deep time and the relative timing of major events in cosmic and biological history. The second episode, also approximately 45 minutes in duration, covers topics such as the chemical basis of life, natural selection and evolution, mutation, artificial selection, early life forms, and the tree of life analogy. Following the viewing session, participants completed the open-ended evaluation forms individually via Google Forms.

4. Findings

In this section, the findings obtained through the content analysis of the data collected from the documentary-based video learning process are presented. Based on the preservice teachers’ responses, themes and codes were identified for the first and second episodes of the documentary. The detailed findings related to the first episode are presented in Table 2, while the findings related to the second episode are presented in Table 3.

Table 2.

Findings from the Content Analysis of the First Episode

Theme	Code	f	Example Preservice Teacher Statement
Conceptual Learning	Size and structure of the universe	32	"I learned that it is an infinite structure and that the Earth is very small in the universe." (PT17)
Conceptual Learning	Origin of life	15	"I learned that life began in water." (PT3)
Conceptual Learning	Perception of time	21	"I realized that the origin of life occurred much later compared to the universe." (PT1)
Conceptual Change	Correction of misconceptions	5	"I thought humans existed much earlier in the universe, but it turns out they are quite recent." (PT12)
Conceptual Change	New perspective	9	"I realized that the origin of life is different from what I previously thought." (PT4)
Interest and Motivation	Interest	6	"We are as small as a speck of dust in the universe." (PT8)
Engagement with Scientific Ideas	Scientific knowledge	7	"I learned that we are located in the Orion Arm of the Milky Way galaxy." (PT5)
Learning through Analogy	Cosmic calendar	11	"Compressing 13.8 billion years into one year made it easier to understand." (PT6)
Learning through Analogy	Concretization of time	7	"Explaining the formation of the universe over a single year helped me better grasp time." (PT7)

According to Table 2, preservice teachers' responses were grouped under five main themes. Many responses were categorized under the theme of conceptual understanding, particularly relating to the structure and size of the universe, the origin of life, and the perception of time. In addition, participants reflected on their prior understandings, described the documentary as engaging, and frequently referred to scientific ideas and explanations in their responses. Furthermore, analogies—particularly the "cosmic calendar" were frequently mentioned by participants and were described as helpful for understanding complex concepts related to deep time.

Within the theme of conceptual learning, participants most frequently referred to the structure of the universe, the origin of life, and the perception of time. Responses within this theme were represented by the codes "structure of the universe," "origin of life," and "perception of time." The findings indicate that documentary-based learning supported the understanding of complex and non-observable concepts. A considerable number of preservice teachers emphasized the vastness of the universe and the relatively small size of the Earth within it.

Similarly, under the theme of the origin of life, preservice teachers indicated that life emerged much later compared to the formation of the universe. Some participants also expressed that life began in water and developed over time through various biological processes. These findings suggest that the documentary contributed to the learning of fundamental scientific concepts related to natural history.

The findings also reveal that preservice teachers corrected some of their misconceptions and developed new perspectives on natural history topics.

Findings related to the perception of time suggest that the cosmic calendar analogy used in the documentary was perceived by participants as helpful for understanding deep time, such as millions and billions of years.

Participants stated that representing the formation of the universe within a one-year timescale made the concept of time more comprehensible.

In addition, participants frequently described the documentary as engaging and referred to scientific concepts in their responses. These responses suggest engagement with the documentary content and reflection on scientific ideas related to natural history.

One of the most notable findings of the study is that many preservice teachers recalled the analogy used in the documentary and referred to it when describing their learning experiences. In particular, the cosmic calendar analogy was frequently mentioned in relation to understanding the formation of the universe and deep time.

The findings obtained from the analysis of the data collected regarding the second episode of the documentary are presented in Table 3.

Table 3.

Findings from the Content Analysis of the Second Episode

Theme	Code	f	Example Quotation
Conceptual Understanding	Artificial selection (human intervention)	14	“The deliberate and purposeful selection and controlled breeding of an organism’s specific traits.” (PT8)
	Natural selection (adaptation and survival)	15	“Evolution that occurs gradually without human influence and is determined by the environment.” (PT23)
	Mutation (genetic change)	10	“Changes that occur in the DNA sequence.” (PT11)
	Evolution of the eye	9	“At first, only light and darkness were perceived, then it gradually developed; I learned that underwater and above-water vision are not the same.” (PT19)
Conceptual Difficulties	Mass extinctions	8	“New species emerged after major extinction events.” (PT20)
	Confusion between natural and artificial selection	3	“Natural selection happens according to how cute living things are.” (PT17)
	Perceiving mutation only as an error	7	“Mutation is an error that occurs in DNA.” (PT12)
Interest and Engagement	Incorrect/irrelevant statements	2	“Wolves evolved and turned into wolves again.” (PT1)
	Interest in the evolution of the eye	18	“The most interesting topic was the evolution of the eye.” (PT16)
	Common ancestor / DNA similarity	10	“I learned that we are related to trees and other living beings.” (PT14)
Engagement with Scientific Ideas	General interest in evolutionary processes	7	“I was very interested in evolution, mutation, and selection.” (PT26)
	Reference to Darwin	11	“Charles Darwin” (PT8)
	Emphasis on scientific explanations	6	“Scientific explanations helped me understand the topic.” (PT10)
Learning through Analogy	Tree of life analogy	18	“The tree of life shows living beings as branches of a tree.” (PT4)
	Understanding relationships through analogy	6	“The branches on the tree show that species are connected to each other.” (PT28)

As shown in Table 3, preservice teachers’ responses regarding the second episode were grouped under five main themes: conceptual understanding, conceptual difficulties, interest and engagement, engagement with Scientific Ideas, and learning through analogy. Many responses were categorized under the theme of conceptual understanding, particularly relating to artificial selection, natural selection, mutation, the evolution of the eye, and mass extinctions. However, some preservice teachers experienced conceptual

difficulties, especially in relation to mutation and selection, and occasionally used incorrect or incomplete explanations. In addition, many participants described the documentary as engaging, referred to scientific concepts and explanations in their responses, and were able to interpret the analogies presented in the documentary.

Under the theme of conceptual understanding, preservice teachers were observed to use accurate and scientific expressions. In particular, statements emphasized that artificial selection involves human intervention, whereas natural selection is related to adaptation and survival. Furthermore, topics such as the evolution of the eye and mass extinctions were expressed from a process-oriented and scientific perspective.

Within the theme of conceptual difficulties, it was observed that some preservice teachers perceived mutation solely as an “error” and confused the concepts of natural selection and artificial selection. These findings indicate that some participants held a superficial understanding of these concepts and had not fully constructed the underlying scientific processes.

A considerable number of preservice teachers reported that they found the documentary engaging and showed particular interest in specific topics. In this regard, the evolution of the eye emerged as the most attention-grabbing topic. In addition, relationships among living organisms and DNA similarities were also identified as interesting topics. These findings suggest that the documentary contributed not only to cognitive learning but also to the affective dimension of the learning process.

Within the theme of engagement with scientific ideas, many preservice teachers referred to Charles Darwin and other scientific explanations when discussing evolutionary processes. These responses suggest that participants associated the documentary content with scientific concepts and figures commonly linked to evolutionary theory. In addition, participants’ references to scientific explanations indicate engagement with scientific ideas presented in the documentary.

Under the theme of learning through analogy, many participants referred to the “tree of life” analogy and were able to describe it accurately. Participants frequently associated this analogy with understanding relationships among living organisms. These responses suggest that analogy-based representations may help learners interpret complex and non-observable concepts.

5. Discussion

The findings of this study suggest that participants reported conceptual understandings related to natural history topics following the documentary-based learning experience. The preservice students’ statements, particularly regarding the structure of the universe, the origin of life, and the perception of time suggest that such learning environments facilitate the comprehension of complex and non-observable concepts. This finding is consistent with studies emphasizing that the combined use of visual and auditory elements enhances learning within the framework of the Cognitive Theory of Multimedia Learning (Mayer, 2002). It is also aligned with research highlighting the positive impact of visual materials in domains involving deep time, such as astronomy and natural history (Impey et al., 2023).

The findings further reveal that preservice teachers not only acquired new knowledge but also questioned their existing knowledge and corrected some of their misconceptions. These responses suggest that participants reflected on their prior understandings and reported learning new information through the documentary experience. This interpretation is consistent with the Cognitive Theory of Multimedia Learning, which suggests that learners construct understanding by integrating new information with prior knowledge (Mayer, 2002).

Findings related to the perception of time indicate that the cosmic calendar analogy played a significant role in helping preservice teachers understand the concept of deep time. Representing extensive time periods using a familiar temporal unit contributed to the concretization of abstract concepts. This result is consistent with studies demonstrating that the use of analogies supports conceptual learning in science education and helps learners construct mental models (Harrison & Treagust, 2006).

However, findings from the viewing of the second documentary suggest that, while many participants were able to describe evolutionary processes and concepts such as artificial selection, natural selection, and mutation, certain conceptual difficulties remained evident. Participants' responses reflected engagement with these concepts; however, some described mutation solely as an "error" and occasionally confused natural selection with artificial selection. These findings indicate that commonly reported misconceptions in evolution education may persist despite exposure to documentary-based learning experiences.

The literature on evolution education suggests that individuals encounter various cognitive and conceptual barriers when attempting to understand evolutionary processes (Bishop & Anderson, 1990; Sinatra et al., 2008). Among these barriers are the perception of evolution as a purposeful and directed process, the belief that organisms change intentionally or consciously, and the view of evolution as a linear progression. In particular, the perception of evolution as a "hierarchical ladder" is cited in the literature as a common conceptual misconception (Gregory, 2009; Catley et al., 2005). The presence of similar misconceptions among some preservice teachers in this study supports these findings.

On the other hand, many preservice teachers were able to accurately describe the "tree of life" analogy and used it when explaining evolutionary relationships. This finding is consistent with studies suggesting that analogies can serve as cognitive bridges in the interpretation of abstract concepts (Treagust et al., 1998). Participants' explanations further suggested an understanding of evolution as a branching and diversifying process rather than a linear progression.

From the perspective of natural history education, evolution constitutes a central concept that provides a framework for understanding changes in living organisms over time (Mayr, 2001). In this study, preservice teachers' ability to express the relationships among mass extinctions, biodiversity, and evolutionary processes indicates that they developed a more holistic understanding of natural history.

In addition, participants frequently referred to scientific concepts, natural phenomena, and scientists in their responses, suggesting engagement with the scientific ideas presented in the documentary. Participants also described the documentary as interesting and engaging. These findings are consistent with studies suggesting that video-based learning environments can promote learner engagement and encourage active participation in learning processes (Kay, 2012; Hsin & Cigas, 2013).

Overall, documentary-based multimedia learning appears to provide valuable opportunities for engaging with complex and non-observable topics such as natural history. Participants' responses suggested that visualizations and analogies were helpful in interpreting concepts related to deep time, evolution, and the origin of life. However, some misconceptions and partial understandings remained evident, particularly regarding evolutionary processes. These findings highlight the importance of providing additional learning opportunities and instructional support when teaching complex scientific concepts.

This study has several limitations that should be considered when interpreting the findings. First, the study was conducted with a relatively small group of preservice teachers from a single public university in Türkiye. Second, the findings were based on participants' written responses collected after viewing two documentary episodes. Therefore, the findings should be interpreted within the context of this qualitative case study and should not be generalized to broader populations. Future research may examine documentary-based learning experiences with different participant groups and through the use of multiple data sources.

6. Conclusion and Suggestions

The findings of this study, which examined preservice teachers' understandings of natural history topics following video documentary-based learning, suggest that participants' responses reflected conceptual understandings related to the structure of the universe, the origin of life, deep time, and evolutionary processes within the framework of the Cognitive Theory of Multimedia Learning.

Participants' responses suggested that they reflected on their prior understandings and reconsidered some previously held ideas regarding natural history concepts. Their explanations indicated engagement with

scientific concepts and an effort to make sense of topics related to the origin of life, evolution, and deep time.

Participants frequently referred to the “cosmic calendar” analogy when explaining the concept of deep time, suggesting that it was helpful in making large temporal scales more comprehensible. Similarly, many participants referred to the “tree of life” analogy when describing evolutionary relationships, indicating that analogy-based representations may assist learners in interpreting complex scientific concepts and processes. Participants frequently used scientific expressions when discussing concepts such as artificial selection, natural selection, mutation, the evolution of the eye, and mass extinctions.

In conclusion, understanding natural history concepts such as deep time, the formation of the universe, the emergence of life, and evolution presents unique challenges due to their abstract and large-scale nature. The findings of this study suggest that documentary-based multimedia learning environments may provide useful opportunities for engaging with these concepts through visualizations and analogy-based explanations.

Despite these findings, the study is limited by its qualitative design, reliance on self-reported responses, and the inclusion of participants from a single institution. Therefore, the findings should be interpreted within the context of the study.

Based on the findings, documentary-based multimedia learning environments may serve as useful instructional resources for teaching natural history and other abstract scientific topics. The incorporation of analogies, such as the cosmic calendar and tree of life, may be particularly valuable in supporting learners’ engagement with complex concepts. In addition, teacher education programs may benefit from providing preservice teachers with greater opportunities to engage with documentary-based and multimedia-supported learning experiences.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this manuscript, AI-assisted language editing tools were used to improve grammar, clarity, and overall readability. The author carefully reviewed and edited the content to ensure accuracy and academic integrity. The final version of the manuscript is the sole responsibility of the author.

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