Earth Puzzle Activity: Past, Future, and Biodiversity

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The Earth has changed geologically throughout the last 4.6 billion years since it was formed. Because these changes happen at an extremely slow pace, they are hard to notice in a human lifetime and hard to learn about. The objective of the study is to delineate the design of the "Earth Puzzle Activity," created to enhance comprehension of continental changes in the Earth's geological structure, in accordance with the ADDIE model, and to present the data acquired from its execution. The study utilized the design and development process and included 15 third-year pre-service teachers from various disciplines who were enrolled in an elective Natural History course during the Fall semester of the 2024–2025 academic year. During the evaluation phase, the last stage in the ADDIE design paradigm, content analysis was used to look at answers to two open-ended questions. The results indicated that participants were able to describe the interlocking nature of continents, recognize possible relationships between continental drift and biodiversity, provide evidence-based explanations regarding these processes, and generate predictions about future continental configurations. These findings suggest that the Earth Puzzle Activity may support participants' understanding of continental change and biodiversity-related concepts. However, since the evaluation was based on responses to two open-ended questions, the findings should be interpreted cautiously and as reflections of participants' expressed understandings rather than direct measures of learning gains or scientific thinking skills.

Keywords: ADDIE instructional design model, continental drift, Pangea, teacher training/education, puzzle-based activity design.

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Introduction

The Earth was formed about 4.6 billion years ago and has since been continuously shaped and transformed due to ongoing geological processes (Hutton, 1788). Such transformations drive the geological evolution of the Earth's structure (Polat & Ontario, 2016). One part of this transformation occurred around 335 million years ago; all the landmasses came together to form a single supercontinent. Wegener (1915) gave this supercontinent the name "Pangea," which is derived from an Ancient Greek word that means "all lands" or "whole Earth." The presence of similar fossils across continents separated by oceans provided evidence that these landmasses were once joined, he stated, noting that the coastlines of Africa and South America fit together like puzzle pieces. Around 175 million years ago, Pangea started to slowly disintegrate, giving rise to the continents that exist today (Scotese, 2001). Rocks with similar structures found on different landmasses and fossils of the same organisms found on different continents are cited as proof that the continents were once joined together (Wegener, 1915; Nance et al., 2014).

Geographic isolation of species, differentiation, the emergence of new species, and an increase in biodiversity were all made possible by continental drift (Coyne & Orr, 2004; Upchurch, 2008). On different scales, geological changes are still occurring today. For example, the Anatolian landmass, which is in a geologically active region, is moving westward at an average annual rate of 20–24 mm in comparison to the Eurasian Plate (Dewey & Şengör, 1979; Demirel et al., 2016).

However, the human mind finds it difficult to grasp such slow processes. It is necessary to develop scientific thinking abilities, a cognitive method of reasoning, in addition to scientific knowledge, to comprehend these changes. Understanding the evolutionary processes that account for organisms' changes and diversification over time requires this viewpoint (Dalrymple, 2001; Futuyma, 2013). Tectonic activity, climate change, volcanic eruptions, and mass extinctions all affect evolutionary trajectories, making Earth's geological transformations and biological evolution interdependent processes (Stanley, 2009; Benton, 2015).

Darwin (1859) grounded his ideas on evolution in the fossil record and the geological findings presented in Charles Lyell's Principles of Geology, published in 1830, one of the founders of geology. One major challenge in comprehending both biological and geological evolutions is that these processes span millions of years and thus cannot be directly observed within a human lifetime (Dagher & BouJaoude, 2005). Moreover, these changes occur within complex, slow-moving systems, making them difficult to conceptualize (Willis et al., 2021). Consequently, due to the difficulty of scientifically scaling these processes in educational settings, understanding how such natural phenomena operate solely through reading textbooks also becomes challenging (Yeh & McTigue, 2009).

The instructional materials used to teach biological evolution and continental drift, two complex natural processes that take place over millions of years, are useful tools for helping students understand abstract, complex, and hard-to-understand concepts and processes (Fer, 2011; Şensoy & Yıldırım, 2016). It has been demonstrated that visual aids such as timelines, maps, graphs, and animations improve students' academic performance and engagement, especially

when used to illustrate processes that are not readily visible (İnel & Sezer, 2017; Kalkan & Yener, 2022).

One type of educational resource that facilitates learning is the puzzle. By encouraging students to combine separate pieces into a meaningful whole, puzzles promote active engagement, problem-solving skills, and meaningful knowledge construction (Davis et al., 2009; Melero et al., 2013). In addition, puzzle-based activities have been reported to foster meaningful learning, provide opportunities to test intuitive thinking, improve collaboration among students, and promote positive attitudes toward learning (Patacsil, 2021).

Puzzles are used by educators and practitioners in instructional settings to enhance the learning value, promote more meaningful and lasting learning, and improve performance in achieving learning objectives across various application and analysis stages (Lu et al., 2020). In a study in Indonesia involving a puzzle activity related to the positioning of islands, it was found that students' learning was enhanced using puzzles (Arbai & Prasetyaningtyas, 2024). Although puzzle-based instructional materials have been used in different educational contexts, studies focusing specifically on continental drift, Pangaea reconstruction, and biodiversity within a single instructional activity remain limited. Existing studies generally use puzzles to support learning in mathematics, geography, or general science education. In contrast, the Earth Puzzle Activity was designed to help participants simultaneously understand past continental configurations, evidence for continental drift, the relationship between continental movement and biodiversity, and possible future continental configurations. Furthermore, the activity was systematically developed and evaluated using the ADDIE instructional design model. Therefore, the present study contributes to the literature by presenting both the development process and implementation of a puzzle-based activity addressing complex geological and biological processes. In this study, the "Earth Puzzle" instructional material was developed as a visual aid to concretely represent the Earth's transformations and facilitate their comprehension. Each of the continents that make up the present-day configuration of the Earth can be taken as separate pieces, and when these pieces are fitted together seamlessly in a complementary way, they form Pangaea, the state of the Earth about 300 million years ago. This material allows pre-service teachers to grasp changes more easily in the Earth's geological structure.

The ADDIE instructional design model guided the creation of the Earth Puzzle activity, which used Earth Puzzle materials. ADDIE, one of the most popular models in instructional design, provides a cyclical and systematic framework that makes it possible to plan efficient teaching procedures. The acronym for the model is derived from the initials of the five basic phases: analysis, design, development, implementation, and evaluation (Branch, 2009). Analysis, learners' needs, past knowledge, and the educational context are all thoroughly examined in the first phase. Learning objectives, content structure, instructional strategies, and assessment techniques are decided upon during the design phase. The development phase creates and concretizes the instructional materials and content based on this design. The instructional process is started during the implementation phase when the target group receives the developed materials. Lastly, the evaluation phase uses both formative assessments at the beginning of the

process and summative assessments at the end to test the model's efficacy (Molenda, 2003). The selection of the ADDIE model in the present study was based on its ability to provide a systematic framework for the design, implementation, and evaluation of instructional activities. In addition, its iterative structure enabled revisions to be made following the pilot implementation.

This study aimed to develop an activity using the Earth Puzzle material to facilitate understanding of continental drift and its effects on biodiversity and to describe the design, implementation, and evaluation of the activity.

Method

The instructional activity created to meet a particular learning objective was designed, implemented, and evaluated in this study using the Design and Development Research methodology. According to Richey and Klein (2008), this method is an applied research approach that attempts to methodically design a new instructional product or process and test it in an implementation context.

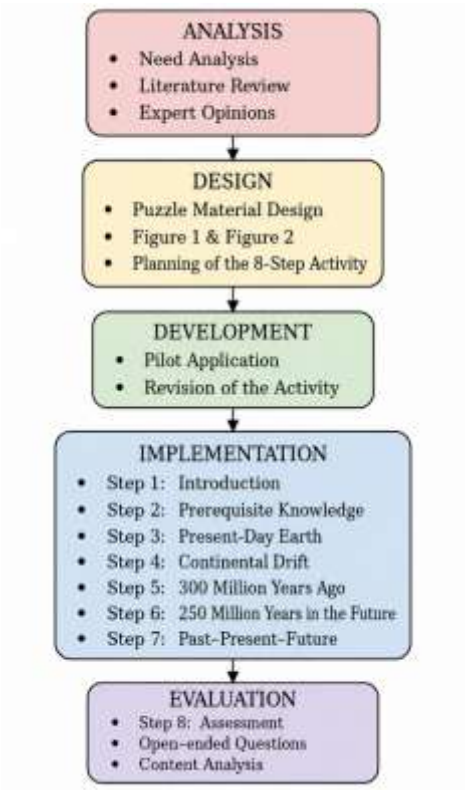


Figure 1

ADDIE-Based Development and Implementation Process of the Earth Puzzle Activity

The study group consisted of 15 third-year pre-service teachers enrolled in the elective Natural History course at a state university during the 2024–2025 academic year. The participants were from different teacher education programs, including Social Studies Education, Chemistry Education, Music Education, and English Language Teaching.

Below are the design stages of the Earth Puzzle activity created for the Natural History course using the ADDIE instructional design model. Figure 1 presents the stages of the study and the main activities carried out within each stage**.**

Stage of Needs Analysis

According to the literature, the need for this activity was emphasized by considering the human lifespan, the difficulty of perceiving the changes that the Earth has undergone over millions of years, the significance of understanding Earth's changes for understanding biological evolution, and the importance of these concepts in developing a scientific thinking approach as a way of thinking. In addition to the literature review, expert opinions were obtained from a palaeontology expert, a geography education specialist, and a biology education specialist. The experts reviewed the activity content, the scientific accuracy of the information presented, and the suitability of the activity for pre-service teachers. Based on their feedback, revisions were made to the explanations related to fossil evidence, continental drift, and biodiversity, and the sequence of some activity steps was refined to improve clarity and coherence.

The Stages of Design

A puzzle material representing the supercontinent Pangea, formed approximately 300 million years ago when today’s continents were joined together, was designed.

During the design phase, the literature was first reviewed to examine existing activities related to teaching Pangea. For the material developed for this study, a world map was printed on colored, thick cardboard, and the continents were cut out to create the puzzle pieces. Two separate puzzle sets were prepared: one with only the names of the continents (Figure 2) and another with both the continent names and the names of relevant fossils (Figure 3).



Figure 2

Present configuration

Pre-service teachers were planned to work in groups to reach conclusions through discussion and collaboration. Group members were selected from different departments to encourage a more diverse exchange of knowledge and richer interaction among participants. The activity consists of eight steps. The description of the steps is provided below, and the detailed implementation plan of the activity is included in the appendix.



Figure 3

300 million years ago configuration

Step 1: Introduction / Getting Started

At the beginning of the activity, four questions are asked to stimulate curiosity, activate prior knowledge, and engage students' interest. The questions and their purposes are as follows:

To reveal prior knowledge about whether the Earth has changed since its formation:

"Where is the Tethys Sea located?"

To elicit thoughts on whether species have remained the same since their emergence and, if changes occurred, the role of continental separation in this process:

"Why does the kangaroo naturally live only on the Australian continent? What do you know about the platypus? Why has it only been found on the Australian continent?"

To encourage the use of scientific thinking methods as a way of reasoning:

"If the geological structure of the Earth has changed, how has this information been determined?"

To reveal predictions about ongoing changes and the possible positions of continents in the future:

"If you traveled 250 million years into the future in a time machine, how would the Earth look from space?"

Step 2: Prerequisite Knowledge

Students must have prerequisite knowledge about the Earth's layered structure to comprehend Pangea and continental drift. At this stage, a brief film that explains the Earth's stratified structure is shown. The video is watched interactively, with pauses for clarifications when needed. You can watch the video at https://youtu.be/Zs0PTR75984.

Step 3: Present-Day Earth

At this step, puzzle pieces bearing the names of the continents and pictures of the *Mesosaurus*, *Cynognathus*, *Lystrosaurus*, and *Glossopteris* species are given to each group. Students are asked to put these parts together to depict Earth's present-day structure.

Step 4: Explanation of Continental Drift

At this step, a short video demonstrates how continents have moved (https://youtu.be/SR-g9BPalSk). Additionally, students are informed that the Anatolian landmass, where we live, drifts approximately 2.5 cm per year.

Step 5: 300 million Years Ago

This step begins by asking the question: "What was the structure of the Earth 300 million years ago?" Then, each group is given a puzzle set representing the Earth 300 million years ago, including images of Mesosaurus, Cynognathus, Lystrosaurus, and Glossopteris, as well as the names of the continents. The following information about the species is provided:

Mesosaurus – Although it lived in water and had swimming limbs, it was not a strong enough swimmer to cross large bodies of water such as the Atlantic Ocean.

Cynognathus – A land-dwelling, mammal-like reptile from the Early Triassic period. Its fossils are found only in South Africa and South America, and it could not cross the Atlantic Ocean.

Lystrosaurus – A land-dwelling, mammal-like reptile whose anatomy indicates that it was not a strong swimmer.

Glossopteris – A fern with very heavy seeds that could not be dispersed by wind or ocean currents. Fossils of this plant have been found on all southern continents, including Australia, Antarctica, India, South Africa, and South America.

Using this information, students are asked to complete the puzzle by examining how the continents might have been positioned 300 million years ago, aligning their boundaries and considering the locations of the fossils.

Step 6: 250 million Years in the Future

Students are asked to place their predicted continental configuration on a piece of cardboard after discussing in groups how continents might be positioned 250 million years from now. They then discuss their predictions using artificial intelligence, compare their findings to four distinct models put forth by scientists, choose one, and reassemble the puzzle in accordance with it. For this stage, participants used ChatGPT as an AI-supported discussion tool. They compared their own predictions with scientific future supercontinent scenarios and discussed similarities and differences between their predictions and the models proposed by scientists. In this process, participants were encouraged to use the resources provided within the activity, including the article on future continental configurations, to support their discussions and decision-making. Link: https://evrimagaci.org/kitalarin-250-milyon-yil-sonraki-gelecegi-dunya-yuz-milyonlarca-yil-sonra-nasil-gozukecek-7486.

Step 7: Past, Present, and Future

In this step, pre-service teachers attach representations of the continents from 300 million years ago, the present day, and 250 million years in the future onto a single piece of cardboard, as illustrated in Figure 3.

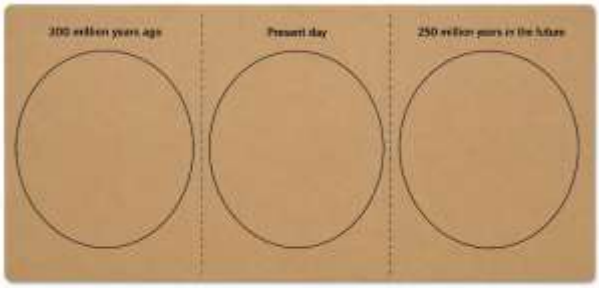


Figure 4

Continents configurations cardboard

Step 8: Assessment

Each group compares their predictions for 250 million years in the future and discusses any differences. At the end of the activity, two open-ended questions are given in writing to conclude the session.

Stage of Development

A pilot application of the activity was conducted with pre-service teachers from different departments at the Faculty of Education. The activity was revised based on the feedback obtained from this pilot application. Based on feedback obtained during the pilot implementation, several revisions were made to improve the clarity and flow of the activity. Additional explanations regarding fossil evidence and continental drift were incorporated, instructions for some activity steps were clarified, and the sequencing of the activity was refined to facilitate participants' understanding of the relationships between continental change and biodiversity.

Stage of Implementation

After receiving feedback from the pilot, 15 pre-service teachers from various departments enrolled in the same state university's Selective Natural History course participated in the "Earth Puzzle Activity" during the 2024–2025 academic year. The participants were studying Social Studies, Chemistry, Music, and English Language Teaching. The activity was implemented according to the steps described in the design stage. The activity was implemented in a regular classroom setting and lasted approximately 60 minutes. During the implementation process, the instructor facilitated discussions, provided explanations when needed, guided participants through the activity steps, and supported group interactions.

Stage of Evaluation

The ADDIE instructional design model recommends both formative and summative evaluation in the evaluation stage. In this study, a summative evaluation was conducted. The results were

based on the analysis of answers given by pre-service teachers to two open-ended questions asked in Stage 8.

The questions and their purposes were as follows:

"What did you learn about the positioning of continents 300 million years ago through this activity?" was the question posed to fulfil the study's goal of increasing awareness of Earth's changes and exposing the evidence of those changes.

To examine how continental drift affects species diversification, the question, "What did you learn about the effects of continental drift on species diversification through this activity?" was posed.

The analysis of these questions and the findings obtained from the analysis are presented in the following sections. Since the evaluation of the activity was based solely on participants' responses to two open-ended questions, the findings should be interpreted as reflections of participants' expressed understandings rather than direct measures of learning gains or skill development.

Data Analysis

Content analysis was used to examine the answers to the open-ended questions. According to Yıldırım and Şimşek (2005), content analysis involves a thorough examination of collected data and the use of a descriptive approach to group and interpret similar data under common concepts and themes. The researchers created codes and themes after conducting the analysis on their own. The Miles and Huberman (1994) formula was used to determine the inter-rater reliability between the two researchers. It is advised that there be more than 70% agreement between researchers and experts in qualitative research (Miles & Huberman, 1994). With an agreement rate of 92.42%, this study's reliability is at the appropriate level. Following the initial coding process, similar codes were grouped under broader categories based on conceptual similarities. Participant responses were examined line by line and assigned to the most appropriate code according to their content. Representative quotations were then selected to illustrate the identified codes and categories presented in the findings section.

Findings

The findings obtained from the analysis of responses to the question about what students learned regarding the positioning of continents 300 million years ago are presented in Table 1.

The responses to the question about what they learned regarding the positioning of the continents 300 million years ago were categorized into three groups: supercontinent, evidence, and future prediction. All pre-service teachers indicated that the continents were once joined as a supercontinent, the majority noted that there is evidence supporting the continents being together, and they also provided predictions about how the continents might be positioned in the future.

Table 1.

Analysis of responses to the question regarding the configuration of continents 300 million years ago

Category	N (frequency)	Code / Frequency	Example statement
Supercontinent	N (15)	Whole continent / 9 The continents as a single landmass / 4 Present continents and plates / 2	*It was a single and united supercontinent.* *The present continents were once together.* *The supercontinent broke apart and formed today's continents.*
Evidence	N (8)	Fossil evidence / 4 Puzzle / 4	*The presence of same fossils on different continents indicates that they were once joined.* *It is evidence that the continents fit together like a puzzle.*
Future prediction	N (7)	Reunited in millions of years / 5 Future supercontinent / 2	*In the future, another supercontinent will form.* *Continents may drift and merge with others to form a larger continent.*

The findings obtained from the analysis of the responses to the question concerning the effects of continental drift on biodiversity are presented in Table 2.

Table 2.

The effect of continental drift on the diversification of living things

Category	N (frequency)	Example statement
Evidence N (10)	Fossil records /10	*Fossils prove that biodiversity increased as continents separated.*
Geographic distributions N (7)	Same species on different continents /4	*After the oceans formed, microorganisms increased biodiversity.*
		A living creature can be found on every continent.
	Similar features in the same continents /3	*As continents drift apart, creatures that drift apart can acquire new characteristics.*
		Different species of organisms exhibit similar characteristics on the same continents.
		Dinosaur fossils are not found in Anatolia.

The responses of pre-service teachers to the question about what they learned regarding the effects of continental drift on biodiversity were categorized into two groups: evidence and geographic distribution. Most pre-service teachers provided evidence based on fossil records, indicating the relationship between continental drift and the diversification of organisms. Others inferred this relationship from the geographic distribution patterns of organisms. It should be noted that some responses focused on evidence supporting continental drift itself rather than directly explaining its relationship with biodiversity.

Conclusion and Discussion

Overall, the findings indicate that pre-service teachers were able to provide detailed responses about the positions of the continents 300 million years ago and the possible effects of continental drift on biodiversity. These responses suggest that participants were able to express their understanding of the positions of continents in the past and the possible effects of continental drift on biodiversity. Similarly, Aral et al. (2012) reported that puzzle-based educational materials supported children's learning and engagement during the instructional process.

All pre-service teachers responded that Pangaea was a supercontinent, according to the results. These responses indicate that pre-service teachers were aware of the stage of Earth's geological evolution at which the continents joined together. Additionally, most pre-service teachers provided evidence supporting the existence of Pangaea. According to Chiappetta et al. (2006), the "nature of science" dimension of scientific literacy includes establishing cause-and-effect relationships, seeking explanations for natural phenomena, and using scientific evidence to explain events that cannot be directly observed. These traits are reflected in responses like "*The continents fit together like puzzle pieces*" and "*We know they were joined because the same fossils are found on different continents*." These findings suggest that participants were able to use evidence such as fossil records and continent fit when explaining continental drift. Some pre-service teachers predicted the possible future reconvergence of continents in response to the Pangea question. The ability to make predictions based on experience, research, observations, and evidence is one of the scientific process skills (Akdeniz, 2016; Aslan Efe et al., 2012; Bağcı-Kılıç, 2003; Tan &Temiz, 2003). These responses indicate that some participants were able to make predictions regarding possible future continental configurations based on the information discussed during the activity.

The participants' responses were categorized under evidence and geographic distribution when asked what they had learned about how continental drift affects species diversification. The notion of allopatric speciation brought about by continents serving as geographic barriers was reflected in the responses pertaining to geographic distribution. In a study conducted by Tekkaya and Kılıç (2012) with prospective biology teachers, participants reported that comprehending the mechanisms of allopatric speciation brought on by geographic barriers was one of the difficulties in learning evolution. The responses suggest that participants were able to relate continental drift to species diversification and geographic isolation. For instance, a few participants' responses, such as *"After the formation of oceans, microorganisms contributed to an increase in species diversity*" and "*Species that became geographically separated due to*

continental drift could develop new traits," illustrate how participants related continental drift to species diversification and geographic isolation.

These findings suggest that participants were able to describe the interlocking nature of continents, recognize possible relationships between continental drift and biodiversity, provide evidence-based explanations regarding these processes, and generate predictions about future continental configurations. The responses also indicate that participants used evidence when explaining continental change and biodiversity-related phenomena. However, since the evaluation was based solely on responses to two open-ended questions, these findings should be interpreted as reflections of participants' expressed understandings rather than direct measures of learning gains, scientific literacy, or scientific process skills.

References

Akdeniz, A. R. (2016). Problem çözme, bilimsel süreç ve proje yönteminin fen eğitiminde kullanımı. In S. Çepni (Ed.), *Kuramdan uygulamaya fen ve teknoloji öğretimi* (pp. 222–249). Pegem Akademi.

Aral, N., Gürsoy, F., & Can-yaşar, M. (2012). İlköğretim beşinci sınıf çocuklarının öğrenmelerinde yapboz eğitim materyalleri ile yapılan uygulamanın etkisinin incelenmesi. Ankara Sağlık Bilimleri Dergisi, 1(1), 157-170. https://doi.org/10.1501/Asbd_0000000012

Arbai, D. T., & Prasetyaningtyas, F. D. (2024). Development of puzzle-based learning to improve science learning outcomes of Indonesian geographic conditions for fifth-graders. *Research and Development in Education (RaDEn), 4*(2), 1169–1186. https://doi.org/10.22219/raden.v4i2.33392

Aslan Efe, H., Efe, R., & Yücel, S. (2012). Ortaöğretim Biyoloji Ders Kitaplarında Yer Alan Etkinliklerin Bilimsel Süreç Becerileri Açısından Analizi. Mehmet Akif Ersoy University Journal of Education Faculty, 1(24), 1-20. https://izlik.org/JA87GX65SR

Bağcı-Kılıç, G. (2003). Üçüncü Uluslararası Matematik ve Fen Araştırması (TIMSS): Fen Öğretimi, Bilimsel Araştırma ve Bilimin Doğası. *İlköğretim Online,* 2(1), 42-51

Benton, M. J. (2015). *Vertebrate paleontology* (4th ed.). Wiley-Blackwell.

Branch, R. M. (2009). *Instructional design: The ADDIE approach*. Springer.

Chiappetta, E. L., Ganesh, T. G., Lee, Y. H., & Phillips, M. C. (2006, April). Examination of science textbook analysis research conducted on textbooks published over the past 100 years in the United States. In *annual meeting of the National Association for Research in Science Teaching, San Francisco, CA.*

Coyne, J. A., & Orr, H. A. (2004). *Speciation*. Sinauer Associates.

Dagher, Z. R., & Boujaoude, S. (2005). Students' Perceptions of the Nature of Evolutionary Theory. *Science Education*, 89, 378-391.

Dalrymple, G. B. (2001). *The age of the Earth*. Stanford University Press.

Darwin, C. (1859). *On the origin of species*. John Murray.

Davis, T. M., Shepherd, B., & Zwiefelhofer, T. (2009). Reviewing for exams: Do crossword puzzles help in the success of student learning. *The Journal of Effective Teaching*, 9(3), 3–9.

Demirel, M., Tatar, O., & Koçbulut, F. (2016). Kuzey Anadolu Fay Zonu Üzerinde Koyulhisar (Sivas) ve Yakın Çevresindeki Fayların Kinematik Özellikleri. *Türkiye Jeoloji Bülteni*, *59*(3), 357-370.

Dewey, J. F., & Şengör, A. C. (1979). Aegean and surrounding regions: complex multiplate and continuum tectonics in a convergent zone. *Geological Society of America Bulletin*, *90*(1), 84-92.

Fer, S. (2011). *Öğretim tasarımı*. Anı Yayıncılık.

Futuyma, D. J. (2013). *Evolution* (3rd ed.). Sinauer Associates.

Hutton, J. (1788). X. Theory of the Earth; or an Investigation of the Laws observable in the Composition, Dissolution, and Restoration of Land upon the Globe. *Earth and Environmental Science Transactions of the Royal Society of Edinburgh*, *1*(2), 209-304.

İnel, Y., & Sezer, A. (2017). Coğrafya konuların öğretiminde materyal kullanımının öğrenci başarısına etkisi: Bir meta analiz çalışması/The effect of the usage of instructional materials on student achievement in teaching geography: A meta-analytic study. *Journal of History Culture and Art Research*, *6*(3),473-491.

https://doi.org/10.7596/taksad.v6i3.913

Kalkan, K., & Yener, D. (2022). Astronomi öğretiminde materyal ve model destekli etkinliklerin öğrenci başarısı ve tutuma etkisi. *Fen Bilimleri Öğretimi Dergisi*, 10 (2), 406- 441. https://doi.org/10.56423/fbod.1182074

Lu, S.-J., Liu, Y.-C., Chen, P.-J., & Hsieh, M.-R. (2020). Evaluation of AR embedded physical puzzle game on students' learning achievement and motivation on elementary natural science. *Interactive Learning Environments, 28*(4),451-463. https://doi.org/10.1080/10494820.2018.1541908

Lyell, C. (1837). *Principles of geology* (Vol. 1). Murray.

Melero, J., Santos, P., Hernández-Leo, D., & Blat, J. (2013). Puzzle-based games as a metaphor for designing in situ learning activities. In *Proceedings of the 7th European Conference on Games Based Learning (ECGBL 2013)* (Vol. 2, pp. 674–682). Academic Conferences and Publishing International.

Miles, M. B., & Huberman, A. M. (1994). Qualitative data analysis: An expanded sourcebook (2nd ed.). Sage.

Molenda, M. (2003). In search of the elusive ADDIE model. *Performance Improvement, 42*(5),34-36. https://doi.org/10.1002/pfi.4930420508

Nance, R. D., Murphy, J. B., & Santosh, M. (2014). The supercontinent cycle: A retrospective essay. *Gondwana Research*, *25*(1),4–29. https://doi.org/10.1016/j.gr.2012.12.026

Patacsil, D. (2021). Games and puzzles as teaching strategies in mathematics. *Asian Journal of Multidisciplinary Studies, 4*(2), 36–40.

Polat, A., & Ontario, K. (2016). Yer küre üzerindeki yaşamın kökenine ve evrimine jeolojik bir bakış açısı. *Mavi Gezegen*, (21), 3-15.

Richey, R. C., & Klein, J. D. (2008). *Research on design and development.* In J. M. Spector, M. D. Merrill, J. van Merriënboer, & M. P. Driscoll (Eds.), *Handbook of research on educational communications and technology* (3rd ed., pp. 748–757). Lawrence Erlbaum Associates.

Scotese, C. R. (2001). *Atlas of Earth history* (Vol. 1: Paleogeography). PALEOMAP Project.

Stanley, S. M. (2009). *Earth system history* (3rd ed.). W. H. Freeman.

Şensoy, Ö., & Yıldırım, H. İ. (2016). 8. sınıf fen ve teknoloji dersinde üç boyutlu görsel materyal kullanımının başarıya ve tutuma etkisinin araştırılması. *Türk Eğitim Bilimleri Dergisi*, *14*(1), 85-102.

Tan, M., & Temiz, B. K. (2003). Fen öğretiminde bilimsel süreç becerilerinin yeri ve önemi. *Pamukkale Üniversitesi Eğitim Fakültesi Dergisi*, *13*(13), 89-101.

Tekkaya, C., & Kılıç, D. S. (2012). Biyoloji öğretmen adaylarının evrim öğretimine ilişkin pedagojik alan bilgileri. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, *42*(42), 406-417.

Upchurch, P. (2008). Gondwanan break-up: legacies of a lost world? *Trends in Ecology & Evolution*, *23*(4), 229–236.

Wegener, A. (1915). *Die Entstehung der Kontinente und Ozeane*. Vieweg.

Willis, S., Stern, R. J., Ryan, J., & Bebeau, C. (2021). Exploring best practices in geoscience education: Adapting a video/animation on continental rifting for upper-division students to a lower-division audience. *Geosciences*, *11*(3), 140. https://doi.org/10.3390/geosciences11030140

Yeh, Y. F. Y., & McTigue, E. M. (2009). The frequency, variation, and function of graphical representations within standardized state science tests. *School Science and Mathematics*, *109*(8), 435-449.

Yıldırım, A., & Şimşek, H. (2005). *Sosyal bilimlerde nitel araştırma yöntemleri*. Seçkin Yayıncılık.

Appendix

Earth Puzzle Activity Plan

<table>
<tr><td colspan="2">EARTH PUZZLE ACTIVITY PLAN</td></tr>
<tr><td colspan="2">I. PART I / IDENTITY</td></tr>
<tr><td colspan="2">Objective: To enable students to understand the structure of Pangaea and the impact of continental drift on the diversification of living organisms, to explain these natural processes using scientific thinking, and to use their skills in predicting the future positioning of continents.

Target Audience: Groups aged 20 and over with an interest in nature.

Duration: 60 minutes

Outcomes

1. Explain that Pangaea was a single continent where today's continents were together approximately 300 million years ago.

2. Provides evidence that Pangaea's current continents were together approximately 300 million years ago.

3. Explain the impact of continental drift on the diversification of living organisms using scientific thinking/evidence.

4. Make predictions about the future positioning of continents based on current scientific data.</td></tr>
<tr><td colspan="2">II. PART II/ IMPLEMENTATION OF THE ACTIVITY</td></tr>
<tr><td>1. Step

10 dk</td><td>Getting Started

Four questions are asked to spark curiosity, activate prior knowledge, and capture their attention.

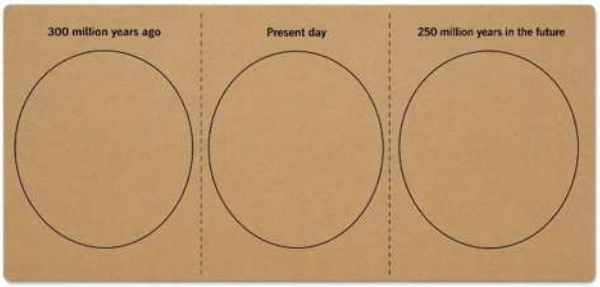
1. "Where is the Tethys Sea?"

2. "Why is the kangaroo's natural habitat only on the Australian continent? What do you know about the platypus? Why has it only been found on the Australian continent?"

3. If you traveled 250 million years into the future in a time machine, how would you see the Earth from space?

4. If the Earth's geological structure had changed, how was the information about this obtained?</td></tr>
<tr><td>2. Step</td><td>Prerequisite Knowledge</td></tr>
</table>

5 dk	To understand the location of the continents 300 million years ago and how they drifted, a basic understanding of the Earth's layered structure is essential. A short video provides information about the Earth's layered structure. The video is interactive and can be viewed interactively, with pauses and explanations provided as needed. The video can be accessed at https://youtu.be/Zs0PTR75984
3. Step **10 dk**	**Earth Puzzle (Today)** In this stage, each group is given a puzzle with the names of the continents and living things written on it, and they are asked to use these pieces to reconstruct the Earth's current structure.
4. Step **5 dk**	**Explanation of Continental Drift** At this stage, a video briefly explains how the continents move (https://youtu.be/SR-g9BPalSk). It is stated that the Anatolian land mass we live on is shifting approximately 2.5 cm every year.
5. Step **10 dk**	**Earth Puzzle (Pangea/300 million years ago)** The question is asked, "What was the structure of the Earth like 300 million years ago?" A group is given a puzzle with fossils and the names of the continents. They are asked to complete the puzzle by examining how the continents might have been positioned 300 million years ago, the alignment of the continental borders, and the continents where the fossils are found.
6. Step **10 dk**	**Earth Puzzle (250 million years from now)** In this step, the group is asked to discuss how the continents will be positioned 250 million years from now and paste the continent shapes they made onto cardboard. Then, using artificial intelligence, they are asked to discuss their predictions, determine which of the four different continents the scientists have modeled, and then reassemble the puzzle. https://evrimagaci.org/kitalarin-250-milyon-yil-sonraki-gelecegi-dunya-yuz-milyonlarca-yil-sonra-nasil-gozukecek-7486
7. Step **5 dk**	**Past, Present, Future** Three different puzzle shapes are glued to a large horizontal piece of cardboard, with the dates written on top. Writing the date is important for remembering the history of Pangaea. Then, after the AI application, the names of the previous and next continents are written on the cardboard.

	
8. Step **5 dk**	**Assessment** At the end of the lesson, the following questions will be answered in writing. 1. What I learned about the locations of the continents 300 million years ago through this activity. 2. What I learned about the diversification of life through this activity.