GLOBAL PERSPECTIVES IN EDUCATIONAL RESEARCH

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ISBN
978-625-375-274-3

Book Title
Global Perspectives in Educational Research

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Publishing Coordinator
Yasin DİLMEN

Page and Cover Design
Typesetting and Cover Design by Akademisyen

Publisher Certificate Number
47518

Printing and Binding
Vadi Printing Press

Bisac Code
SCI049000

DOI
10.37609/akya.3476

Library ID Card
Global Perspectives in Educational Research / ed. Semra Mirici, Duygu Sönmez.
Ankara : Academician Bookstore, 2024.
280 p. : table, figure. ; 160x235 mm.
Includes References.
ISBN 9786253752743

GENERAL DISTRIBUTION
Akademisyen Kitabevi A.Ş.

Halk Sokak 5 / A
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CHAPTER 1

AN INVESTIGATION OF THE TEACHERS' VIEWS ON THE CHALLENGES FOR STUDENTS WITH SPEECH AND LANGUAGE DISORDER IN THE FOREIGN LANGUAGE LEARNING PROCESS

Hakan SARI[1]
Hikmet Beyza YAKICI[2]

INTRODUCTION

The concepts of language and speech are different. While language is a means of agreement that people develop to communicate, speaking is one of the most prominent ways of communicating language (Topbaş, 2007). On the other hand, speech and language disorders refers to a situation in which an individual cannot speak due to disruptions in language development, even though the speech organs function perfectly. Alternatively, it may occur when an individual has the necessary linguistic knowledge, but the speech organs (tongue, lips, etc.) cannot perform their tasks as required. (American Speech-Language-Hearing Association-ASHA, 2007). Individuals with speech and language disorders are classified as fluency disorders, language disorders, acquired language disorders, speech sound disorders, motor speech disorders, voice disorders, and resonance disorders (Ministry of National Education-MEB, 2018). These disorders can negatively affect the individual's educational performance and social adaptation (Çiyiltepe, 2005). A study conducted on students with speech and language disorders in Türkiye stated that delayed speech, stuttering, pronunciation and voice disorders, and specific learning disabilities were the most common types of disorders (Maviş, 2011).

While speech and language disorders cause students to struggle with basic language skills such as comprehension, production, reading, and writing (McLeod &

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REFERENCES

American Speech-Language-Hearing Association. (2007). *The scope of practice in speech-language pathology*. Retrieved from https://www.asha.org

Ateş, E., Sarı, H., & Balcı, M. (2024). Teachers' perspectives on the classroom participation of students with speech and language disorders. *Pearson Journal*, 8(28), 1388–1402.

Büyüköztürk, Ş. (2018). *Handbook of data analysis for social sciences*. Ankara: Pegem Akademi.

Çiyiltepe, M. (2005). Language and concept development. In S. Topbaş (Ed.), *Language and concept development*. Ankara: Kök Publishing.

Maviş, İ. (2011). Students with speech and language disorders. In İ.H. Diken (Ed.), *Students with special needs in education and special education* (4th ed.,). Ankara: Pegem Akademi.

McLeod, S., & McKinnon, D. H. (2007). Prevalence of communication disorders compared with other learning needs in 14,500 primary and secondary school students. *International Journal of Language and Communication Disorders, 42*(1), 37–59.

Ministry of National Education. (2018). *Special education services regulation*. Retrieved from https://orgm.meb.gov.tr/meb

Mirici, İ. H. (2001). *Teaching foreign languages to children*. Ankara: Gazi Publishing.

Sadler, J. (2005). Knowledge, attitudes, and beliefs of mainstream teachers of children with a preschool speech/language impairment diagnosis. *Child Language Teaching and Therapy, 21*(2), 147–163.

Tanrıdağ, O. (2009). Speech and language disorders in neurological practice. *Turkish Journal of Neurology, 15*, 155–160.

Togram, B., & Maviş, İ. (2009). Evaluation of attitudes and knowledge of parents, teachers, and speech-language therapists about speech and language disorders in children. *Ankara University Faculty of Educational Sciences Journal of Special Education, 10*(1), 71–85.

Topbaş, S. (2007). Communication-language-speech connection in the evolution process of spoken language, language, and concept development. In S. Topbaş (Ed.), *Language and concept development*. Ankara: Kök Publishing.

Uysal-Aydın, A., & Tura, G. (2018). An evaluation of prospective teachers' attitudes and knowledge about speech and language disorders in children. *Kocaeli University Journal of Education, 1*(1), 13–22.

Yıldırım, A., & Şimşek, H. (2021). *Qualitative research methods in social sciences* (12th ed.). Ankara: Seçkin Publishing.

BÖLÜM 2

ANALYSIS OF ACRONYMS AND EPONYMS IN SECONDARY BIOLOGY TEXTBOOKS[1]

Dilara KARACA [2]
Duygu ÜLGER [3]
Sultan ÇIKRIK [4]

INTRODUCTION

Textbooks are essential resources that organize and present information on curriculum subjects systematically. They guide and educate students in alignment with course objectives, serving as primary sources of information (Ünsal & Güneş, 2002). A textbook is a fundamental resource designed to teach a specific course to students at a particular level, with content aligned to the curriculum and reviewed and approved for accuracy (Gülersoy, 2013). In the Regulation on Textbooks published in 2016, the Ministry of National Education defines a textbook as a book approved by the Board of Education and Instruction to be taught in formal and non-formal education and training institutions. The preparation of textbooks by the education programs adopted by the Ministry of National Education is one of the most critical conditions of educational practices. For this reason, it is necessary first to prepare the education programs that will form the basis of the textbooks and then prepare the textbooks by these programs (Demirel & Kıroğlu, 2021).

Textbooks remain one of the most essential educational materials for both students and teachers. Although many different methods and materials have been developed and used over the years and many things have changed in the field of education and training, textbooks still maintain their importance (Yapıcı, Coşkun, & Akbayın, 2009). In the education programs, the aims of education are included, and therefore, it is emphasized which desired characteristics should be developed

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- Book authors and educators should take care not only to include terms but also to support them with clear, precise, and contextualized explanations. In addition, including a "glossary of terms" on topics where acronyms are frequently used can contribute to students' learning process.
- In the future, conducting such studies more comprehensively in different disciplines will increase the effectiveness of the terminology used in educational materials. At the same time, feedback studies with students can provide additional data on the comprehensibility of these terms. Enriching textbooks with student-centered and understandable content will be possible.

REFERENCES

Alberta. (2006). Adapted primary literature: An untapped resource for high school biology education. Alberta Innovation & Science ISRIP Science Awareness & Promotion Program, University of Calgary Kananaskis Field Stations.

Bahar, M. (2000). Determination of learning and comprehension difficulties in science education and investigation of solutions with information processing model. *IV. Science Education Congress*, 6-8 September, Hacettepe University, Ankara.

Barker, S., & Julien, H. (2012). *Reading for evidence*. In Stephen P. Norris (Ed.), Reading for evidence and interpreting visualizations in mathematics and science education (pp. 19-40). The Netherlands: Sense Publishers.

Budrys, V. (2005). Neurological eponyms derived from literature and visual art. *Eur Neurol*., *53*: 171-178.

Cabré, M. T. (1999). *Terminology: theory, methods and applications*. Philadelphia: John Benjamin Publishing Company.

Cankur, N. Ş. (2002). Language in medical education: importance, development and future. *Journal of Uludag University Faculty of Medicine*. 1: 29-32.

Corbin, J., & Strauss, A. (2008). *Basics of qualitative research: Techniques and procedures for developing grounded theory*. Thousand Oaks: Sage.

Çobanoğlu, E., Şahin, B., & Karakaya, C. (2009). Examination of the biology textbook for 10th grades in high school education and the ideas of the pre-service teachers. *Procedia - Social and Behavioral Sciences*, 1(*1*), 2504-2512.

Demir, C. (2006). The problem of terminology in Turkish grammar. *Turkish Language Research Yearbook - Bulletin*, 54(*1*), 81-100.

Demirel, Ö., & Kıroğlu, K. (2021). *Education and textbooks*. In Ö. Demirel, K. Kıroğlu (Eds.), Textbook review (4-11. pp.). Ankara: Pegem Akademi.

Fargen, K. M., & Hoh, B. L. (2014). The debate over eponyms. *Clin. Anat*., *27*: 1137-1140.

Forster, N. (1995). *The analysis of company* documentation. In C. Cassell and G. Symon (Eds). Qualitative methods in organisational research: A practical guide. London: Sage Publications.

Göktolga, O. (2002). Turkishisation of Management Science and Political Science Terms in the Republican Period. Master Thesis. İnönü University, Institute of Social Sciences.

Gülersoy, A. E. (2013). Analysing Social Studies Textbooks in Terms of Some Features in the Search for Ideal Textbooks. *International Journal of New Trends in Arts, Sports & Science Education* (IJTASE), 2(*1*), 8-26.

Güneş, G. (2008). The problem of foreign terms in biology education and Turkish terminology study. Master Thesis. Gazi University, Institute of Educational Sciences.

İmer, K., Kocaman, A., & Özsoy, A. S. (2011). *Dictionary of linguistics*. Istanbul: Boğaziçi University Publishing House.

Kılıç, D. (2021). *The place of textbook in teaching*. Ö. Demirel, K. Kıroğlu (Ed.), Textbook review (38-49. pp.). Ankara: Pegem Akademi.

Lederman, N. G. (2004). *Syntax of nature of science within inquiry and science instruction*. In Lawrence B. Flick & Norman G. Lederman (Eds.), Scientific inquiry and nature of science: Implications for teaching, learning, and teacher education (301-317. pp.). Dordrecht, the Netherlands: Kluwer Academic Publishers.

Mora, B., & Bosch, X. (2010). Medical eponyms: time for a name change. *Archives of Internal Medicine*, *170*(16), 1499-1500.

Oğuz, D. (2014). Translation problems of medical texts. *Journal of International Social Research*, *7*(34), 127-134.

Olry, R. (2004). Anatomical eponyms, part 1: to look on the bright side. *Clin Anat*., 27(*8*), 1142-1144.

Öztaş, F. (2001). Research on the Problems Encountered by High School Students in Biology Education. Master Thesis. Atatürk University, Institute of Science and Technology.

Özay, E., & Hasenekoğlu, G. (2007). Some problems observed in visual presentation in high school-3 biology textbooks. *Turkish Journal of Science Education*, 4(*1*), 80-91.

TDK (2005). *Turkish dictionary*. Ankara: Turkish Historical Society Press Office.

Ünsal, Y., & Güneş, B. (2002). As an example of a book review study, a critical look at the M.E.B. primary school 4th grade science textbook in terms of physics subjects. *Journal of Gazi Faculty of Education*, 22(*3*), 110-120.

Wach, E., & Ward, R. (2013). *Learning about qualitative document analysis*. IDS Practice Paper in Brief 13, Brighton: IDS.

Vardar, B. (2007). *Dictionary of linguistics terms with explanations.* Istanbul: Multilingual.

Yapıcı, İ. Ü., Coşkun, Y., & Akbayın, H. (2009). An example of a book review study: Critical examination of the MoNE 10th grade biology textbook. I. International Educational Research Congress, Çanakkale.

Yıldırım, A. (1999). Basic features of qualitative research methods and their place and importance in educational research. *Education and Science,* 23(*112*), 7-11.

Yıldırım, A., & Şimşek, H. (2013). *Qualitative research methods in social sciences*. Ankara: Seçkin Publishing.

CHAPTER 3

ARTIFICIAL INTELLIGENCE INTEGRATION INTO EDUCATION: TRANSFORMATION OF TEACHING PROCESSES AND CHANGES IN TEACHERS' ROLE

Yüksel ALTUN [1]

INTRODUCTION

Artificial intelligence (AI) represents one of the most groundbreaking advancements in contemporary technology, driving transformative changes across various disciplines. At its core, AI relies on the capability of machines and computer systems to emulate—and in some cases surpass—human cognitive processes. Characterized by data-driven decision-making, learning, and adaptability, AI can revolutionize the foundational structures of teaching and learning when employed effectively (Miao et al., 2023; Rahayu, 2023).

In the field of education, AI applications enable educators to thoroughly analyze student performance, address individual learning needs, and develop adaptive learning systems to enhance the learning experience (Zawacki-Richter et al., 2019; Chen et al., 2020; Miao et al., 2023; de Souza Zanirato Maia et al., 2023; Fitria, 2023; Annuš, 2024a; Annuš, 2024b). These systems improve student management for educational leaders and facilitate transparent and effective learning processes. By enhancing learning outcomes, AI offers a novel perspective on teaching practices. However, the widespread adoption of AI also raises significant concerns about its potential effects on teachers' roles and teacher-student interactions (Zawacki-Richter et al., 2019; Miao et al., 2023; Li et al., 2024). These uncertainties highlight the need for teachers to acquire new competencies, such as effectively leveraging technology, refining pedagogical strategies, and optimizing their interactions with students (Miao et al., 2023).

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2024). Similarly, teachers may risk losing their central role in fostering human connections if AI dominates the classroom. To mitigate these risks, a balanced integration of AI is necessary, ensuring that it complements, rather than replaces, human educators (Shah & Asad, 2024; Tamrin & Jark, 2024).

Ethical considerations must remain at the forefront of AI integration in education. Policymakers, educators, and technologists must collaborate to develop ethical frameworks that guide the implementation of AI. These frameworks should prioritize transparency, accountability, and inclusivity, ensuring that AI is a tool for empowerment rather than exclusion (Nazaretsky et al., 2022; Li, 2024).

In conclusion, AI has the potential to revolutionize education by enhancing learning experiences, supporting teachers, and addressing the diverse needs of learners. However, its adoption must be approached with a commitment to equity, ethics, and sustainability. Teachers' roles as mentors, guides, and emotional anchors remain indispensable, as their ability to inspire, empathize, and foster critical thinking cannot be replicated by machines. The education sector can create dynamic, inclusive, and future-ready learning environments by fostering a balanced partnership between AI and human educators. As AI technologies continue to evolve, their integration in education must prioritize the holistic development of students, ensuring that the human touch remains at the heart of teaching and learning.

REFERENCES

Aberbach, H., Jeghal, A., Sabri, A., Tairi, H., &. and Laaouina, L. (., 2021).. A personalized learning approach based on learning speed. *Journal of Computer Science,* 17(3), pp. 242–250. https://doi.org/10.3844/jcssp.2021.242.250.

Akgun, S., & Greenhow, C. (2022). Artificial intelligence in education: Addressing ethical challenges in K-12 settings. *AI and Ethics*, *2*(3), 431–440.

Alam, A. (2021). Possibilities and apprehensions in the landscape of artificial intelligence in education. 2021 International Conference *on Computational* Intelligence and Computing Applications (ICCICA), pp. 1–8.

Alam, F., Lim, M. A., & Zulkipli, I. N. (2023). Integrating AI in medical education: Embracing ethical usage and critical understanding. *Frontiers in Medicine*, *10*, Article 1279707.

Alkan, A. (2024). Yapay zekâ: Eğitimdeki rolü ve potansiyeli. *Itobiad: Journal of the Human & Social Science Researches/İnsan ve Toplum Bilimleri Araştırmaları Dergisi*, *13*(1), 483-495.

Al-Khassawneh, Y. A. (2023). A review of artificial intelligence in security and privacy: Research advances, applications, opportunities, and challenges. *Indonesian Journal of Science and Technology*, *8*(1), 79–96.

Al-khresheh, M. H. (2024). The future of artificial intelligence in English language teaching: Pros and cons of ChatGPT implementation through a systematic review. *Language Teaching Research*, *pp. 43*, 54–80.

Almusharraf, N., & Alotaibi, H. (2023). An error-analysis study from an EFL writing context: Human and automated essay scoring approaches. *Technology, Knowledge and Learning*, *28*(3), 1015-1031.

Amyatun, R. L., & Kholis, A. (2023). Can artificial intelligence (AI) like QuillBot AI assist students' writing skills? Assisting learning to write texts using AI. *ELE Reviews: English Language Education Reviews*, *3*(2), 135-154.

Annuš, N. (2023). Weigh the pros and cons of using artificial intelligence in education. *International Journal of Science, Engineering, and Technology*, *11*(3), 2–5.

Annuš, N. (2024a). Educational software and artificial intelligence: Students' experiences and innovative solutions. *Information Technologies and Learning Tools*, *101*(3), 200–226.

Annuš, N. (2024b). Education in the Age of Artificial Intelligence. *TEM Journal*, *13*(1), 404–413.

Aslam, N., Khan, I., Alamri, L., & Almuslim, R. (2021). An improved early student's academic performance prediction using deep learning. *International* Journal of Emerging Technologies in Learning (IJET), 16(12), 108–122.

Bacallo, D. L. D., Bie, P. E. G., De Vera, A. R., Dizon, R. C., Marcaida, J. L. M., Pineda, A. J. M., ... & Vicente, A. P. (2024). Digital learning revolution: Identify the influence of dependency on artificial intelligence tools towards the knowledge acquisition of students. *Ignatian International Journal for Multidisciplinary Research*, *2*(8), 1338-1362.

Badawy, H. R., Alkaabi, A. M., Mohsen, W. A., & Alblooshi, K. M. (2024). Developmental supervisory advancements: Refining the art of crafting creative approaches and applications in educational leadership. In *Cutting-Edge Innovations in Teaching, Leadership, Technology, and Assessment* (pp. 100-119). IGI Global.

Baidoo-Anu, D., & Ansah, L. O. (2023). Education in the era of generative artificial intelligence (AI): Understanding the potential benefits of ChatGPT in promoting teaching and learning. *Journal of AI*, *7*(1), 52-62.

Bates, T., Cobo, C., Mariño, O., & Wheeler, S. (2020). Can artificial intelligence transform higher education? *International Journal of Educational Technology in Higher Education*, *17* (42), 1-12.

Bhatia, A., Bhatia, P., & Sood, D. (2024). Leveraging AI to transform online higher education: Focusing on personalized learning, assessment, and student engagement. *International Journal of Management and Humanities (IJMH)*, *11* (*1*), 1-6.

Bojadjiev, J. (2024). In education: Transforming learning. *Reimagining Intelligent Computer-Assisted Language Education*, 1-61.

Borger, J. G., Ng, A. P., Anderton, H., Ashdown, G. W., Auld, M., Blewitt, M. E., ... & Naik, S. H. (2023). Artificial intelligence takes center stage: Exploring the capabilities and implications of ChatGPT and other AI-assisted technologies in scientific research and education. *Immunology and cell biology*, *101*(10), 923–935.

Boulord, C., Le Borgne, Y. A., & Corieri, P. (2024). Informal education practices for human-AI creative pedagogy for accessibility and inclusivity. In *Creative Applications of Artificial Intelligence in Education* (pp. 89-99). Cham: Springer Nature Switzerland.

Bower, M., Torrington, J., Lai, J. W., Petocz, P., & Alfano, M. (2024). How should we change teaching and assessment in response to increasingly powerful generative artificial intelligence? Outcomes of the ChatGPT teacher survey. *Education and Information Technologies*, pp. 1–37.

Buckingham Shum, S., & Luckin, R. (2019). Learning analytics and AI: Politics, pedagogy, and practices. *British Journal of Educational Technology*, **50**(6), 2785–2793.

Bui, N. M., & Barrot, J. S. (2024). ChatGPT as an automated essay scoring tool in the writing classrooms: how it compares with human scoring. *Education and Information Technologies*, pp. 1–18.

Bukar, U. A., Sayeed, M. S., Razak, S. F. A., Yogarayan, S., & Sneesl, R. (2024). Decision-Making Framework For The Utilization of Generative Artificial Intelligence in Education: A Case Study of ChatGPT. *IEEE Access, 12,* 95368-95389.

Cai, Z. (2024). Research on teachers' role orientation and strategies in the age of artificial intelligence. *Advances in Educational Technology and Psychology*, *8*(4), 1–8.

Carruba, M. C., Barca, A., & Cesarano, V. P. (2024). Emotional skills in the age of artificial intelligence at school: Teachers' training and students' outcomes. *Italian Journal of Health Education, Sport and Inclusive Didactics*, *8*(2), 1-11.

Carvalho, L., Martinez-Maldonado, R., Tsai, Y., Markauskaite, L., & De Laat, M. (2022). How can

we design for learning in an AI world? Computers and Education: Artificial Intelligence, 3(1), 100053.

Cavalcanti, A. P., Barbosa, A., Carvalho, R., Freitas, F., Tsai, Y. S., Gašević, D., & Mello, R. F. (2021). Automatic feedback in online learning environments: A systematic literature review. *Computers and Education: Artificial Intelligence*, *2*, 100027.

Chan, L., Hogaboam, L., & Cao, R. (2022). Artificial intelligence in education. In *Applied Artificial Intelligence in Business: Concepts and Cases* (pp. 265-278). Cham: Springer International Publishing.

Chaudhary, S. (2023). Harnessing technology to enable access to education for all: A study of opportunities created by adoption of technology in education. *International Journal of Applied Science and Technology Research Excellence*, 12(5), 37–51.

Chaudhry, M. A., & Kazim, E. (2022). Artificial intelligence in education (AIEd): A high-level academic and industry note 2021. *AI and Ethics*, *2*(1), 157–165.

Chen, D., & Xu, F. (2024). Design and implementation of machine learning algorithms in automatic grading of students' assignments. *Journal of Electrical Systems*, *20*(3s), 899-919.

Chen, L., Chen, P., & Lin, Z. (2020). Artificial intelligence in education: A review. *IEEE Access*, 8, 75264–75278.

Chen, X., Xie, H., Zou, D., & Hwang, G. J. (2020). Application and theory gaps during the rise of artificial intelligence in education. Computers and Education: Artificial Intelligence, 1, 100002.

Chen, X., Zou, D., Xie, H., Cheng, G., & Liu, C. (2022). Two decades of artificial intelligence in education: Contributors, collaborations, research topics, challenges, and future directions. Educational Technology & Society, 25(1), 28–47.

Coelho, L., & Reis, S. (2025). Transforming teaching and learning with natural language processing. In *Integrating Artificial Intelligence in Education: Enhancing Teaching Practices for Future Learning* (pp. 119-152). IGI Global.

Crompton, H., Jones, M. V., & Burke, D. (2024). Affordances and challenges of artificial intelligence in K-12 education: A systematic review. *Journal of Research on Technology in Education*, *56*(3), 248–268.

Cui, P., & Alias, B. S. (2024). Opportunities and challenges in higher education arising from AI: A systematic literature review (2020–2024). *Journal of Infrastructure, Policy, and Development*, *8*(11), 8390.

Daftary, M. N., Jorden, J., Habib, M., Pather, I., & Tofade, T. (2020). Implementing virtual experiences and remote assessments during the COVID-19 pandemic: A college experience: Innovation in experiential learning or assessment. *Pharmacy Education*, *20*(2), 54-55.

Dennis, N. K. (2024). Using AI-powered speech recognition technology to improve English pronunciation and speaking skills. *IAFOR Journal of Education*, *12*(2), 107–126.

de Souza Zanirato Maia, J., Bueno, A. P. A., & Sato, J. R. (2023). Applications of Artificial Intelligence Models in Educational Analytics and Decision Making: A Systematic Review. *World*, *4*(2), 288-313.

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011, September). From game design elements to gamefulness: Defining "gamification". In *Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments* (pp. 9–15).

Devasena, R. (2024). Artificial intelligence in education: An alternative to traditional learning. *Journal of English Language Teaching*, *66*(1), 13–21.

Ding, L., & Zou, D. (2024). Automated writing evaluation systems: A systematic review of Grammarly, Pigai, and Criterion with a perspective on future directions in the age of generative artificial intelligence. *Education and Information Technologies*, 1-53.

Dirkin, K., & Miller, L. (2024, March). All in on AI: A course redesign to empower today's educators for tomorrow's decisions. In *Society for Information Technology & Teacher Education International Conference* (pp. 2032-2035). Association for the Advancement of Computing in Education (AACE).

Duggan, S. (., 2020).. *AI in education: Change at the speed of learning.* UNESCO IITE.

Dutta, S., Ranjan, S., Mishra, S., Sharma, V., Hewage, P., & Iwendi, C. (2024, February). Enhancing educational adaptability: A review and analysis of AI-driven adaptive learning platforms. In *2024 4th International Conference on Innovative Practices in Technology and Management (ICIPTM)* (pp. 1–5). IEEE.

Egliston, B., Carter, M., & Clark, K. E. (2024). Value and virtue in the extended reality (XR) industry. *Information, Communication & Society*, pp. 1–20.

Ejjami, R. (2024). The future of learning: AI-based curriculum development. *International Journal of Multidisciplinary Research*, *6*(4).

Elshani, L., & Nuçi, K. P. (2021). Constructing a personalized learning path using a genetic algorithms approach. *arXiv preprint arXiv:2104.11276*.

Fang, C., & Lu, Q. (2021). [Retracted] Personalized recommendation model of high- quality education resources for college students based on data mining. *Complexity*, *2021*(1), 9935973.

Faramarzi, S., & Dayag, J. D. (2023). Augmented reality and virtual reality: New frontiers in technology-enhanced language learning. In *Perspectives on Enhancing Learning Experience Through Digital Strategy in Higher Education* (pp. 166-189). IGI Global.

Fernández-Batanero, J. M., Montenegro-Rueda, M., Fernández-Cerero, J., & García-Martínez, I. (2022). Digital competencies for teacher professional development: Systematic review. *European Journal of Teacher Education*, *45*(4), 513-531.

Fırat, M. (2023). Integrating AI applications into learning management systems to enhance e-learning. *Instructional Technology and Lifelong Learning*, *4*(1), 1–14.

Fitria, T. N. (2023). The use of artificial intelligence in education (AIEd): Can AI replace the teacher's role? *Epigram (e-Journal)*, *20*(2), 165-187.

Fountoulakis, M. S. (2024). Evaluating the impact of AI tools on language proficiency and intercultural communication in second language education. *International Journal of Second and Foreign Language Education*, *3*(1), 12-26.

Fu, Y., & Weng, Z. (2024). Navigating the ethical terrain of AI in education: A systematic review on framing responsible human-centered AI practices. *Computers and Education: Artificial Intelligence*, 100306.

Galindo-Domínguez, H., Delgado, N., Losada, D., & Etxabe, J. M. (2024). An analysis of the use of artificial intelligence in education in Spain: The in-service teacher's perspective. *Journal of Digital Learning in Teacher Education*, *40*(1), 41-56.

Gao, R., Merzdorf, H. E., Anwar, S., Hipwell, M. C., & Srinivasa, A. (2024). Automatic assessment of text-based responses in post-secondary education: A systematic review. *Computers and Education: Artificial Intelligence*, 100206.

Ghafar, Z. N., Salh, H. F., Abdulrahim, M. A., Farxha, S. S., Arf, S. F., & Rahim, R. I. (2023). The role of artificial intelligence technology on English language learning: A literature review. *Canadian Journal of Language and Literature Studies*, *3*(2), 17-31.

Gillani, N., Eynon, R., Chiabaut, C., & Finkel, K. (2023). Unpacking the "Black Box" of AI in education. *Educational Technology & Society*, *26*(1), 99-111.

Gochhayat, L., & Das, S. R. Beyond the classroom walls: Leveraging technology and artificial intelligence for continuous teacher professional development in the modern era.

Goel, A., Sikka, H., & Gregori, E. (2021). Agent Smith: Teaching question answering to Jill Watson. *arXiv preprint arXiv:2112.13677*.

Guilherme, A. (2019). AI and education: the importance of teacher and student relations. *AI & society*, *34*, 47-54.

Handini, B. S., Nurhasanah, N., & Panly, F. I. (2022). The effect of artificial intelligent technology used (Duolingo application) to enhance English learning. *ELLITE: Journal of English Language, Literature, and Teaching*, *7*(2), 86-94.

Hmoud, M., Swaity, H., Hamad, N., Karram, O., & Daher, W. (2024). Higher education students' task motivation in the generative artificial intelligence context: the case of *ChatGPT*: *information*, *15*(1), 33.

Holmes, A. F., & Douglass, A. (2022). Artificial intelligence: Reshaping the accounting profession

and the disruption to accounting education. *Journal of Emerging Technologies in Accounting*, *19*(1), 53–68.

Holmes, W. (2020). Artificial intelligence in education. In *Encyclopedia of Education and Information Technologies* (pp. 88–103). Cham: Springer International Publishing.

Holmes, W., Meng, S., & Yuan, L. (2023). Artificial Intelligence and Education: Digging Beneath the Surface. *The Chinese Journal of ICT in Education*, *2023*(2), 16–26.

Holmes, W., & Miao, F. (2023). *Guidance for generative AI in education and research*. UNESCO Publishing.

Huang, L. (2023). Ethics of artificial intelligence in education: Student privacy and data protection. *Science Insights Education Frontiers*, *16*(2), 2577–2587.

Huang, X., Zou, D., Cheng, G., Chen, X., & Xie, H. (2023). Trends, research issues, and applications of artificial intelligence in language education. *Educational Technology & Society*, *26*(1), 112–131.

Hwang, G. J., Xie, H., Wah, B. W., & Gašević, D. (2020). Vision, challenges, roles, and research issues of Artificial Intelligence in Education. *Computers and Education: Artificial Intelligence*, *1*, 100001.

Ivanashko, O., Kozak, A., Knysh, T., & Honchar, K. (2024). The role of artificial intelligence in shaping the future of education: opportunities and challenges. *Futurity Education*, *4*(1), 126-146.

Jafari, F., & Keykha, A. (2024). Identifying the opportunities and challenges of artificial intelligence in higher education: a qualitative study. *Journal of Applied Research in Higher Education*, *16*(4), 1228-1245.

Jayanti, W. M. M., Firdaus, M. Y., & Arochman, T. (2024). The effectiveness of integrating Classcraft: A gamified learning platform on enhancing writing skills among elementary school learners. *English Learning Innovation*, *5*(2), 277-286.

Johnson, D., Mamani, B., & Salas, C. (2024). CollabVR: VR Testing for Increasing Social Interaction between College Students. *Computers*, *13*(2), 40.

Käser, T., & Alexandron, G. (2024). Simulated learners in educational technology: A systematic literature review and a Turing-like test. *International Journal of Artificial Intelligence in Education*, *34*(2), 545-585.

Kasneci, E., Seßler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., ... & Kasneci, G. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. *Learning and Individual Differences*, *103*, 102274.

Katonane Gyonyoru, K. I. (2024). The Role of AI-based Adaptive Learning Systems in Digital Education. *Journal of Applied Technical and Educational Sciences*, *14*(2), 1-12.

Kenchakkanavar, A. Y. (2023). Exploring the artificial intelligence tools: Realizing the advantages in education and research. *Journal of Advances in Library and Information Science*, *12*(4), 218-224.

Khairyah, P. N., Anastasya, M., & Natsir, R. Y. (2024). A phenomenological study of English Education Students' perceptions of using DeepL Pro for text translation (English-Indonesian). *IJM: Indonesian Journal of Multidisciplinary*, *2*(6), 610-619.

Kılıç, S. (2024). Use of Artificial Intelligence in Teaching Different Disciplines. In *Interdisciplinary Approach to Fostering Change in Schools* (pp. 220–250). IGI Global.

Kitchenham, B., & Charters, S. (2007). *Guidelines for performing* systematic literature reviews in software engineering. Technical Report, EBSE 2007-001.

Koh, J., Cowling, M., Jha, M., & Sim, K. N. (2023). The human teacher, the AI teacher, and the AIED-Teacher relationship. *Journal of Higher Education Theory & Practice*, *23*(17), 199-211200-212.

Krippendorff, K. (2018). *Content analysis: An introduction to its methodology*. Sage *Publications*.

Kshetri, N., Hughes, L., Louise Slade, E., Jeyaraj, A., Kumar Kar, A., Koohang, A., ... & Wright, R. (2023). "So what if ChatGPT wrote it?" Multidisciplinary perspectives on opportunities, challenges, and implications of generative conversational AI for research, practice, and policy. *International Journal of Information Management*, *71*, 102642.

Lasaiba, D. (2024). Classroom management strategies in the transformation of education in the

digital era: Integration of technology and teaching methodologies. *Jendela Pengetahuan*, *17*(1), 77-95.

Lee, G. G., Latif, E., Wu, X., Liu, N., & Zhai, X. (2024). Applying large language models and chain-of-thought for automatic scoring. *Computers and Education: Artificial Intelligence*, *6*, 100213.

Lee, J. H., Shin, D., & Noh, W. (2023). Artificial intelligence-based content generator technology for young English-as-a-foreign-language learners' reading enjoyment. *RELC Journal*, *54*(2), 508–516.

Li, L., Fengchao, Y., & Zhang, E. (2024). A systematic review of learning task design for K-12 AI education: Trends, challenges, and opportunities. *Computers and Education: Artificial Intelligence*, 100217.

Li, Z. (2024). The shadow of the algorithm: the ethical blind spot of artificial intelligence education. *Journal of Education, Humanities and Social Sciences*, *p. 26*, 1146–1152.

Limna, P., Jakwatanatham, S., Siripipattanakul, S., Kaewpuang, P., & Sriboonruang, P. (2022). A review of artificial intelligence (AI) in education during the digital era. *Advance Knowledge for Executives*, *1*(1), 1-9.

Lin, Z., Yan, H., & Zhao, L. (2024). Exploring an effective automated grading model with reliability detection for large-scale online peer assessment. *Journal of Computer Assisted Learning*, p. 40, 1535–1551.

Liu, J., & Wang, S. (2020). The change of teachers' role in teaching under the environment of "Artificial Intelligence+." In *2020 International Conference on Artificial Intelligence and Education (ICAIE)* (pp. 98-102). IEEE.

Maghsudi, S., Lan, A., Xu, J., &. and van Der Schaar, M. (., 2021).. Personalized education in the artificial intelligence era: What to expect next. *IEEE Signal Processing Magazine,* 38(3), pp. 37–50. https://doi.org/10.1109/MSP.2021.3055032.

Maier, U., & Klotz, D. (2022). Personalized learning support through intelligent tutoring systems. *International Journal of Artificial Intelligence in Education*, **32**(1), 89-105.

Malakar, P., & Leeladharan, M. (2024). Generative AI tools for collaborative content creation: A comparative analysis. *DESIDOC Journal of Library & Information Technology*, *44*(3), 151-157.

Malik, G., Tayal, D. K., & Vij, S. (2019). An analysis of the role of artificial intelligence in education and teaching. In *Recent Findings in Intelligent Computing Techniques: Proceedings of the 5th ICACNI 2017, Volume 1* (pp. 407-417). Springer Singapore.

Martínez-Comesanã, M., Rigueira-Díaz, X., Larrañaga-Janeiro, A., Martínez-Torres, J., Ocarranza-Prado, I., & Kreibel, D. (2023). Impact of artificial intelligence on assessment methods in primary and secondary education: Systematic literature review. *Revista de Psicodidáctica (English ed.)*, *28*(2), 93-103.

McLaren, B. M., & Nguyen, H. A. (2023). Digital learning games in Artificial Intelligence in Education (AIED): A review. *Handbook of Artificial Intelligence in Education*, pp. 440–484.

Mehta, N., Agrawal, A., Benjamin, J., Mehta, S., MacNeill, H., & Masters, K. (2024). Pedagogy and generative artificial intelligence: Applying the PICRAT model to Google NotebookLM. *Medical Teacher*, pp. 1–3.

Miao, F., Shiohira, K., Vally, Z., & Holmes, W. (2023). International forum on AI and education: steering AI to empower teachers and transform teaching, 5-6 December 2022; analytical report.

Michalak, R., & Ellixson, D. (2024). Buy versus build: Navigating artificial intelligence (AI) tool adoption in academic libraries. *Information Services and Use*, 1–11

Mizumoto, A., & Eguchi, M. (2023). Exploring the potential of using an AI language model for automated essay scoring. *Research Methods in Applied Linguistics*, *2*(2), 100050.

Mohsen, M. (2024). Artificial Intelligence in Academic Translation: A Comparative Study of Large Language Models and Google Translate. *Psycholinguistics*, *35*(2), 134–156.

Moodley, D. K., & Nhavoto, R. (2023). An evaluation of the use of Turnitin as a tool for electronic submission, marking, and feedback in higher education in South Africa: Students' perspective. In *Proceedings of The World Conference on Education and Teaching* (Vol. 1, No. 1, pp. 31–43).

Morris, W., Holmes, L., Choi, J. S., & Crossley, S. (2024). Automated scoring of constructed response

items in math assessment using large language models. *International Journal of Artificial Intelligence in Education*, pp. 1–28.

Nee, C. K., Rahman, M. H. A., Yahaya, N., Ibrahim, N. H., Razak, R. A., & Sugino, C. (2023). Exploring the trend and potential distribution of chatbot in education: A systematic review. *International Journal of Information and Education Technology*, *13*(3), 516-525.

Nehring, J., Moyer-Packenham, P., & North, M. (2023). Assessing the effectiveness of an artificial intelligence tutoring system for improving college-level mathematics preparedness in high school students. *Issues in Information Systems*, *24*(1), 128-141.

Nti, I. K., Umar Bawah, F., Quarcoo, J. A., & Kalos, F. (2022). A bibliometric analysis of soft computing technology applications trends and characterisation in educational research: Africa. *Africa Education Review*, *19*(3), 55-77.

Nurbekova, Z., Baigusheva, K., Tuenbaeva, K., Nurbekov, B., & Vassilev, T. (2024). Teachers' adaptation to changes in an increasingly complex world through the use of AI. *Strategies for Policy in Science & Education/Strategii na Obrazovatelnata i Nauchnata Politika*, *32(5), 182-188*.

Obenza, B., Salvahan, A., Rios, A. N., Solo, A., Alburo, R. A., & Gabila, R. J. (2024). University students' perception and use of ChatGPT: Generative artificial intelligence (AI) in higher education. *International Journal of Human Computing Studies*, *5*(12), 5-18.

Onwuagboke, B. B. C., Nnajieto, C., Nzeako, R., & Umune, H. (2024). Lecturers' awareness of artificial intelligence tools for teaching and research in Alvan Ikoku Federal University of Education, Nigeria. *African Journal of Humanities and Contemporary Education Research*, *17*(1), 1-14.

Osama, M. (2024). Artificial intelligence in scientific writing and research publication: A paradigm shift in language inclusivity. Journal of Back and Musculoskeletal Rehabilitation, 37(2), 249–251.

Oumaima, D., Mohamed, L., Hamid, H., & Mohamed, H. (2023, October). Application of artificial intelligence in virtual reality. In *International Conference on Trends in Sustainable Computing and Machine Intelligence* (pp. 67-85). Singapore: Springer Nature Singapore.

Ouyang, F., & Jiao, P. (2021). Artificial intelligence in education: The three paradigms. *Computers and Education: Artificial Intelligence*, *2*, 100020, 1-6.

Owan, V. J., Abang, K. B., Idika, D. O., Etta, E. O., & Bassey, B. A. (2023). Exploring the potential of artificial intelligence tools in educational measurement and assessment. *Eurasia Journal of Mathematics, Science and Technology Education*, *19*(8), em2307, 1-15.

Paez, A. (2017). Gray literature: An important resource in systematic reviews. *Journal of Evidence-Based Medicine*, *10*(3), 233–240.

Panigrahi, A., & Joshi, V. (2020). Use of artificial intelligenceArtificial Intelligence in educationEducation. *The Management Accountant Journal,. 55*, 64-67.

Parab, A. K. (2020). Artificial intelligence in education: teacher and teacher assistant improve learning process. *International Journal for Research in Applied Science and Engineering Technology*, *8*(11), 608–612.

Park, S., & Whang, M. (2022). Empathy in human-robot interaction: Designing for social robots. *International Journal of Environmental Research and Public Health*, *19*(3), 1889.

Petrilli, M. J. (2024). Next-Gen Classroom Observations, Powered by AI: Let's go to the videotape to improve instruction and classroom practice. *Education Next*, *24*(4).

Pham, S. T. H., & Sampson, P. M. (2022). The development of artificial intelligence in education: A review in context. *Journal of Computer Assisted Learning, 38*(5), 1408–1421. Doi: 10.1111/jcal.12687

Pivetti, M., Di Battista, S., Agatolio, F., Simaku, B., Moro, M., & Menegatti, E. (2020). Educational robotics for children with neurodevelopmental disorders: A systematic review. Heliyon, 6(10), e05160.

Rahayu, S. (2023). The impact of artificial intelligence on education: Opportunities and challenges. *Jurnal Educatio FKIP UNMA*, *9*(4), 2132-2140.

Raheem, B. R., Anjum, F., & Ghafar, Z. N. (2023). Exploring the profound impact of artificial intelligence applications (Quillbot, Grammarly, and ChatGPT) on English academic writing: A

systematic review. *International Journal of Integrative Research (IJIR)*, *1*(10), 599-622.

Rahm, L. (2023). Education, automation, and AI: A genealogy of alternative futures. *Learning, Media and Technology*, *48*(1), 6–24.

Rakuasa, H., Faris, D. A., & Hidayatullah, M. (2024). Transforming education in the age of artificial intelligence: Challenges and opportunities in Indonesia, a literature review. *Journal Education Innovation (JEI)*, *2*(1), 180-186.

Rane, J., Kaya, O., Mallick, S. K., & Rane, N. L. (2024). Artificial intelligence in education: A SWOT analysis of ChatGPT and its implications for practice and research. *Generative Artificial Intelligence in Agriculture, Education, and Business*, 142-161.

Rezaei, A. R. (2024). Applications of immersive technologies in education: A systematic literature review. *Advances in Online Education: A Peer-Reviewed Journal*, *2*(3), 232-251.

Robson, R., Kelsey, E., Goel, A., Nasir, S., Robson, E., Garn, M., ... & Ray, F. (2022). Intelligent links: AI-supported connections between employers and colleges. *AI Magazine*, *43*(1), 75-82.

Roll, I., & Wylie, R. (2016). Evolution and revolution in artificial intelligence in education. *International Journal of Artificial Intelligence in Education*, *pp. 26*, 582–599.

Romero, C., & Ventura, S. (2010). Educational data mining: A review of the state of the art. IEEE Transactions on Systems, Man, and Cybernetics Part C: Applications *and Reviews*, 40(6), 601–618.

Rožman, M., Tominc, P., & Vrečko, I. (2023). Building skills for the future of work: Students' perspectives on emerging jobs in the Data and AI Cluster through artificial intelligence in education. *Environment and Social Psychology*, *8*(2), 1-24.

Sari, H. E., Tumanggor, B., & Efron, D. (2024). Improving educational outcomes through adaptive learning systems using AI. *International Transactions on Artificial Intelligence*, *3*(1), 21-31.

Sarker, I. H. (2021a). Deep learning: A comprehensive overview on techniques, taxonomy, applications, and research directions. *SN Computer Science*, 2, 420.

Sarker, I. H. (2021b). Machine Learning: Algorithms, Real-World Applications, And Research Directions. *SN Computer Science*, 2, 160.

Sarker, I. H. (2022). AI-based modeling: Techniques, applications, and research issues towards automation, intelligent and smart systems. SN Computer Science, 3(2), 1–20.

Seo, K., Yoo, M., Dodson, S., & Jin, S. H. (2024). Augmented teachers: K–12 teachers' needs for artificial intelligence's complementary role in personalized learning. *Journal of Research on Technology in Education*, pp. 1–18.

Shah, S. S., & Asad, M. M. (2024). Impact of critical thinking approach on learners' dependence on innovative transformation through artificial intelligence. In *The Evolution of Artificial Intelligence in Higher Education: Challenges, Risks, and Ethical Considerations* (pp. 161-182). Emerald Publishing Limited.

Shakhnoza, O., & Nargiza, I. (2024). Natural language processing (NLP) applications in language teaching. *Contemporary Technologies of Computational Linguistics*, *2*(22.04), 278-283.

Sharma, G., Tripathi, L., Madan, V., & Khatri, E. (2024). A study of teachers' adaptability towards digital education system: An empirical study in higher education perspective. *Journal of Informatics Education and Research*, *4*(2), 644–651.

Sharma, M. D., Sharma, J., & Mehta, N. (2024). Augmented gamification to "Gamification" reality, let's gamification now. *Library Progress International*, *44*(3), 6334-6342.

Shemshack, A., & Spector, J. M. (., 2020). A systematic literature review of personalized learning terms. *Smart Learning Environments,* 7(1), 33. p. 33. https://doi.org/10.1186/s40561-020-00140-9.

Singh, B., Kaunert, C., Lal, S., & Arora, M. K. (2025). Enhancing AI-augmented classrooms: Teacher-centric integration of intelligent tutoring systems and adaptive learning environments. In *Fostering Inclusive Education With AI and Emerging Technologies* (pp. 99-130). IGI Global.

Singla, I., Hans, A., Swami, H. K., & Ranjan, R. (2024). A comprehensive review of recent advances and challenges in artificial intelligence and machine learning. Computational Methods in Science and Technology, 427-431.

Sinha, M. (2024). Balancing education and cybersecurity: Addressing data privacy challenges in schools and higher education. *International Journal of Engineering Fields, 2*(2), 43–49.

Suresh Babu, S., & Dhakshina Moorthy, A. (2024). Application of artificial intelligence in adaptation of gamification in education: A literature review. *Computer Applications in Engineering Education*, *32*(1), e22683.

Suryodiningrat, S. P., Ramadhan, A., Prabowo, H., Santoso, H. B., & Hirashima, T. (2024). Mixed reality systems in education: A systematic literature review. *Journal of Computers in Education*, *11*(3), 855-878.

Swiecki, Z., Khosravi, H., Chen, G., Martinez-Maldonado, R., Lodge, J. M., Milligan, S., Selwyn, N., & Gašević, D. (2022). Assessment in the age of artificial intelligence. *Computers and Education: Artificial Intelligence*, *3*, 100075.

Taher, A. (2023). Stakeholders' opinions support the people-process-technology framework for implementing digital transformation in higher education. *Technology, Pedagogy and Education*, *32*(5), 555–567.

Tamrin, S. I., Omar, N. F., Kamaruzaman, K. N., Zaghlol, A. K., & Aziz, M. R. A. (2024). Evaluating the impact of AI dependency on cognitive ability among Generation Z in higher educational institutions: A conceptual framework. *Information Management and Business Review*, *16*(3S (I) a), 1027-1033.

Tedre, M., Toivonen, T., Kahila, J., Vartiainen, H., Valtonen, T., Jormanainen, I., & Pears, A. (2021). Teaching machine learning in K–12 classrooms: Pedagogical and technological trajectories for artificial intelligence education. *IEEE Access*, *9*, 110558-110572.

Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., Levac, D., ... & Straus, S. E. (2018). PRISMA extension for scoping reviews (PRISMA-ScR): Checklist and explanation. *Annals of Internal Medicine*, *169*(7), 467–473.

Tsai, C. W., Ma, Y. W., Chang, Y. C., & Lai, Y. H. (2022). Integrating multiculturalism into artificial intelligence-assisted programming lessons: Examining inter-ethnicity differences in learning expectancy, motivation, and effectiveness. *Frontiers in Psychology*, *13*, 868698.

Utina, S. S., Chusniyah, T., Inseachiangmai, J., Zahra, G. A., & Pambudi, K. S. (2024). A comparative study of artificial intelligence in education psychology: The cases of Indonesia and Thailand. *Bulletin of Social Informatics Theory and Application*, *8*(1), 70-85.

Villegas-Ch, W. E., García-Ortiz, J., & Sánchez-Viteri, S. (2023). Identification of emotions from facial gestures in a teaching environment with the use of machine learning techniques. *IEEE Access*, *11*, 38010-38022.

Walkington, C., & Bernacki, M. L. (2020). Appraising research on personalized learning: Definitions, theoretical alignment, advancements, and future directions. *Journal of Research on Technology in Education*, *52*(3), 235–252.

Walter, A. (2024). Utilizing language-generating artificial intelligence in educational planning: A case study. *Journal of Interdisciplinary Teacher Leadership*, *8*(1), 29–59.

Williamson, B., Molnar, A., & Boninger, F. (2024). Time for a Pause: Without Effective Public Oversight, AI in Schools Will Do More Harm Than Good.

Wu, Y. (2023). Integrating generative AI in education: how ChatGPT brings challenges for future learning and teaching. *Journal of Advanced Research in Education*, *2*(4), 6–10.

Xia, Q., Chiu, T. K., Zhou, X., Chai, C. S., & Cheng, M. (2022). Systematic literature review on opportunities, challenges, and future research recommendations of artificial intelligence in education. *Computers and Education: Artificial Intelligence*, 100118.

Xu, W., Meng, J., Raja, S. K. S., Priya, M. P., & Kiruthiga Devi, M. (2023). Artificial intelligence in constructing personalized and accurate feedback systems for students. *International Journal of Modeling, Simulation, and Scientific Computing*, *14*(01), 2341001.

Xue, Y., & Zhou, J. (2021). The social role of elementary school teachers in the era of artificial intelligence: Challenges and responses. *International Journal of Frontiers in Sociology*, *3*(18), 129-134.

Yakubboeva, N. S. (2023). Using artificial intelligence in the education system. *Web of Technology: Multidisciplinary Research Journal*, *1*(9), 31–34.

Yamashita, T. (2024). An application of many-facet Rasch measurement to evaluate automated essay scoring: A case of ChatGPT-4.0. *Research Methods in Applied Linguistics*, *3*(3), 100133.

Yao, X. (2022). [Retracted] Design and research of artificial intelligence in multimedia intelligent question-answering system and self-test system. *Advances* in Multimedia, *2022*(1), 2156111.

Yolcu, H. H. (2023). Redefining the teacher's role in education through artificial general intelligence (AGI).

Yuying, L., Kakham, P., Keyuraphan, L., Pholngam, P., & Jujia, C. (2024). Development of strategies for higher vocational teachers' roles based on artificial intelligence in Northern Guangdong. *International Journal of Education and Literacy Studies*, *12*(4), 288–296.

Zargoun, E. (2024). Comparative study the role of artificial intelligence and their impact on teaching and e-learning platforms (Duolingo, ALEKS, Coursera, QuestionPro). *African Journal of Advanced Pure and Applied Sciences (AJAPAS)*, pp. 263–274.

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education–where are the educators? *International Journal of Educational Technology in Higher Education*, *16*(1), 1-27.

Zhang, R., & Zou, D. (2020). Types, purposes, and effectiveness of state-of-the-art technologies for second and foreign language learning. Computer Assisted *Language* Learning, pp. 1–47.

Zhang, T., & Jiang, B. (2022). The role of teachers' orientation in the context of education empowered by artificial intelligence--Based on Emile's teacher role view. In *Society for Information Technology & Teacher Education International Conference* (pp. 2177–2181). Association for the Advancement of Computing in Education (AACE).

Zlatarov, P., Ivanova, E., Ivanova, G., &. and Doncheva, J. (., 2021).. Design and development of a web-based student screening module as part of a personalized learning system. *TEM Journal,* 10(3), 1454–1460. pp. 1454–1460. https://doi.org/10.18421/TEM103-58.

Zmyzgova, T.R., Polyakova, E.N., & Karpov, E.K. (2020). Digital Transformation of Education and Artificial Intelligence. *2nd International Scientific and Practical Conference "Modern Management Trends and the Digital Economy: From Regional Development to Global Economic Growth*," 824–829. Doi: 10.2991/aebmr.k.200502.134.

CHAPTER 4

BIOLOGY TEACHER CANDIDATES' PERSPECTIVES ON VIRTUAL LABORATORY APPLICATIONS

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INTRODUCTION

One of the fundamental conditions for reaching contemporary standards in education is the content being delivered. However, the tools and methods used to effectively convey this content are equally significant. Today, technology has become as indispensable in education as books, teachers, and schools. Technological advancements have led to numerous studies on how these innovations can be used in the planning, implementation, and evaluation of educational processes (Çağıltay & Erdoğmuş, 2009; Lai & Bower, 2019). In the age of information, rapidly advancing technology has an increasing impact on all areas of education (Aydın & Soyer, 2020).

Sciences such as Mathematics, Biology, Physics, and Chemistry are fields that directly influence technological advancements and change. Knowledge and experiences gained in these areas have contributed to the development of technological tools and methods (Demirci, 1993).

Laboratory applications are among the most effective methods in teaching science subjects. However, appropriate conditions for conducting laboratory applications are not always met (Kıyıcı & Yumuşak, 2005). Technical complexities of traditional teaching methods and the abstract nature of certain concepts make it difficult for students to understand topics in STEM (Science, Technology, Engineering, and Mathematics) courses (Zheng, 2015; Yager, 2000). With the opportunities provided by digitalization, new instructional models have emerged in laboratory applications. Today, information and communication technologies (ICT) have reached a level capable of providing the necessary environments and

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Implementing such strategies will support future biology teachers in adapting to technological advancements and providing students with effective and comprehensive learning experiences.

To enhance the role of virtual laboratories in biology teaching, it is crucial to develop educational strategies that allow teacher candidates to strengthen their theoretical knowledge and gain practical experience. The findings of this study indicate that virtual laboratories offer advantages such as **easy access**, **safe experiment environments**, **time-saving**, and **learning motivation**, but challenges such as **lack of real-life experience** and **technical issues** should also be considered.

Combining virtual laboratories with traditional laboratory applications will enable teacher candidates to adapt to technological advancements and provide students with more effective and comprehensive learning experiences.

REFERENCES

Aydın, Ş. Z. N. 2018. Fen bilgisi dersi öğretiminde sanal laboratuvar uygulamasının kullanılması ve değerlendirilmesi. [Yüksek Lisans Tezi]. İstanbul Üniversitesi.

Bozkurt, E. (2008). *Fizik Eğitiminde Hazırlanan Bir Sanal Laboratuvar Uygulamasının Öğrenci Başarısına Etkisi* [Doktora Tezi, Selçuk Üniversitesi].

Büyüköztürk, Ş. (2011). Veri analizi el kitabı. Ankara: Pegem Akademi.

Clark, R. E., & Craık, T. G. (1992). Interactive Multimedia Learning Environments NATO ASI Series f: Computer and System Sciences v.93, Springer, Berlin.

Çağıltay, K. ve Erdoğmuş, F. U. (2009). Türkiye'de eğitim teknolojileri alanında yapılan master ve doktora tezlerinde genel eğilimler.

Demirci, B. (1993). Çağdaş Fen Bilimleri Eğitimi ve Eğitimcileri. *Hacettepe Üniversitesi Eğitim Fakültesi.* 9, 155-160

Glesne, C. (2013). Nitel araştırmaya giriş. (2. Baskı). A. Ersoy, P. Yalçınoğlu, (Çev. Ed.). Ankara: Anı Yayıncılık.

Gündüz, M., Baykan, Ö. K., & Yıldız, F. (2007). Elektronik deneyleri için sanal laboratuar uygulaması. *Selçuk-Teknik Dergisi, 6*(2), 61.

Hatch, J. A. (2002). Doing qualitative research in education settings. Suny Press

Jayarajah, K., Saat, R. M. ve Rauf, R. A. A. (2014). A review of science, technology, engineering & mathematics (STEM) education research from 1999–2013: A Malaysian perspective. Eurasia Journal of Mathematics, Science & Technology Education, 10(3), 155-163.

Kıyıcı, G., ve Yumuşak, A. (2005). Fen bilgisi laboratuvarı dersinde bilgisayar destekli etkinliklerin öğrenci kazanımları üzerine etkisi-asit-baz kavramları ve titrasyon konusu örneği. TOJET: The Turkish Online Journal of Educational Technology, 4(4), 130-134.

Lai, J. W., and Bower, M. (2019). How is the use of technology in education evaluated? A systematic review. Computers & Education, 133, 27-42.

Lin, T. C., Lin, T. J. ve Tsai, C. C. (2014). Research trends in science education from 2008 to 2012: A systematic content analysis of publications in selected journals. International Journal of Science Education, 36(8), 1346-1372.

Merriam, S. B., and Grenier, R. S. (2019). Qualitative research in practice: Examples for discussion and analysis. San Francisco, CA: Jossey-Bass Publishers.

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

M. Akgül, E. Derman, U. Çağlayan ve A. Özgit (Ed.), XI. Akademik Bilişim Konferansı Bildirileri

(s.389-393) içinde, Şanlıurfa: Harran Üniversitesi.
Özkul, A. E. (2003). E-öğrenme ve mühendislik eğitimi. TMOB Elektrik Mühendisleri Odası Dergisi, 41 (419), 18-27.
Pınar, M. A. ve Akgül, G. D. (2021). Sanal ve geleneksel laboratuvar uygulamalarının 7. sınıf öğrencilerinin kuvvet ve enerji ünitesiyle ilgili ders tutum ve motivasyonlarına etkisinin karşılaştırılması. Akdeniz Üniversitesi Eğitim Fakültesi Dergisi, 4(2), 13-25.
Suri, H. ve Clarke, D. (2009). Advancements in research systhesis methods: From a methodologically inclusive perspective. Review of Educational Research, 79(1), 395-430.
Şimşek, F. (2017). Fen bilimleri dersinde animasyon ve simülasyon kullanımının öğrencilerin akademik başarısı ve bilgilerin kalıcılığı üzerine etkisi. Uluslararası Eğitim Bilim ve Teknoloji Dergisi, 3(3), 112-124.
Yerden, A. U., & AKKUŞ, N., (2020). Virtual Reality Remote Access Laboratory for Teaching Programmable Logic Controller Topics. *INTERNATIONAL JOURNAL OF ENGINEERING EDUCATION* , vol.36, no.5, 1708-1721.
Yager R. E., "A vision for what science education should be like for the first 25 years of a new millennium," School Science and Mathematics, vol. 100, no. 6, pp. 327–341, 2000.
Yıldırım, A., & Şimşek, H. (2003). Sosyal bilimlerde nitel araştırma yöntemleri. Ankara: Seçkin.
Zheng S., Rosson M. B., Shih P.C., and Carroll J. M., "*Understanding student motivation, behaviors and perceptions in moocs,*" in Proceedings of the 18th ACM conference on computer supported cooperative work & social computing, 2015, 1882–1895.

CHAPTER 5

CORRECTING MISCONCEPTIONS ABOUT ATOMS AND MOLECULES IN PRIMARY AND SECONDARY SCHOOL STUDENTS USING MODELING TECHNIQUES

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Tahir ATICI [2]

INTRODUCTION

In recent years, science education literature is filled with research reports that define and explain the difficulties students encounter in understanding scientific concepts, and explore ways to improve and correct these issues. The causes for these difficulties have been researched and defined in different ways by various researchers such as; "misunderstandings", "alternative structures", "intuitive judgments", "preconceptions", "natural reasoning (spontaneous conclusions)", "science as understood by students" and "naive beliefs" (Griffiths & Preston, 1992, Luera, Otto & Zitzewitz, 2005).

The concept of matter and its particulate nature, expressed through atoms and molecules, is taught to students starting from the fifth grade as a part of the science curriculum. Matter is composed of atoms and molecules (Nicoll, 2001, Dhindsa & Anderson, 2004, Bilir Digilli & Karaçam, 2018), and its properties are determined by the behavior of these constituent particles.

The aim of this study is to identify the scientific and non-scientific misconceptions regarding atoms and molecules among students in the fifth, sixth, seventh, and eighth grades of primary education, as well as ninth, tenth, and eleventh grades of secondary education. Furthermore, the study seeks to determine the prevalence and causes of these misconceptions and to examine the effectiveness of modeling-based activities in minimizing these misconceptions and enhancing students' understanding of atomic and molecular concepts (Cardoso & et al.,

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REFERENCES

Ben-Zvi, R., Eylon B.S. and Silberstein, E. (1986) Revision of course materials on the basis of research on conceptual difficulties, *J. Chem. Educ*. 63 (1), p 64. DOI: 10.1021/ed063p64.

Bilir V., Digilli B.A. & Karaçam, S. (2018) Atomic theories that preservice science teachers confuse andunderlying reasons. *Inonu University Journal of the Faculty of Education*, 19 (1), 212-220. https://doi.org/10.17679/inuefd.331368

Brook, A., Briggs M. and Driver R. (1984). Aspects of Secondary Students Understanding of the Particulate Nature of Matter. Leeds: *Univercity of Leeds Chidren's Learning in Science Project. Centre for Studies in Science and Mathematics Education*.

Cardoso, P. S. S., Nunes, M. C. S., Silva, G. P. S., Braghittoni, L. S. & Trindade, N. M. (2020) Atomic modelsof high school students, radiation and radioactivity concepts. *Physics Education*, 55 (3), 035030. https://doi.org/10.1088/1361-6552/ab7fc6

Çökelez, A. & Duman, A. (2005) Atom and molecule: upper secondary school french students'representations in long-term memory. *Chemistry Education Research and Practice*, 6 (3), 119-135. https://doi.org/10.1039/B4RP90005G

Çökelez, A. & Yalçın, S. (2012) Investigation of mental models of elementary 7th grade students about atomconcept. *Elementeary Education Online*, 11 (2) 452-471.

Çökelez, A. (2012) Junior high school students' ideas about the shape and size of the atom. *Research in Science Education*, 42, 673-686. https://doi.org/10.1007/s11165-011-9223-8

Demircioğlu, G., Aydın, M. A. & Demircioğlu, H. (2012) The effect of conceptual change text and three-dimensional model on 7th grade students' understanding of atomic structure. *Journal of Bayburt Education Faculty*, 7 (2), 70-96.

Dhindsa, H.S. & Anderson, O.R. (2004) Using a Conceptual-Change Approach to Help Preservice Science Teachers Reorganize Their Knowledge Structuresfor ConstructivistTeaching. *Journal of Science Teacher Education*, 15 (1), 6385.

Dow, W.M., Auld J. and Wilson D. (1978). Pupils Concept of Gases, Liquid and Solids. *Unpublished Manuscript, Dundee Collage of Education,* Dundee.

Ehab O. M., Safwan M. O., Nathir A.F. Al-R., Nacir T. & Ihab M. O. (2018) Misconceptions about atomicmodels amongst the chemistry students. *International Journal for Innovation Education and Research*, 6 (2), 256-263. https://doi.org/10.31686/ijier.vol6.iss2.958

Griffiths, Alan K. and Kirk R. Preston. (1992) Grade 12 Students' Misconceptions Relating to Fundamental Characteristics of Atoms and Molecules. *Journal of Research in Science Teaching*, 29 (6), 611-628.

Harrison, A. G. & Treagust, D. F. (2000) Leaming about atoms, molecules, and chemical bonds: a case study of multiple models uses in grade 11 chemistry. *Science Education*, 84, 352-381.

Lena R., Andersson B. and Marton F. (1990) Students' Conceptions of Matter. *Journal of Educational Pschology,* 82 (3), 555-559.

Luera, GR, Otto, CA., & Zitzewitz, P.W. (2005) A conceptual change approachto teaching energy & thermodynamics to pre-service elementary teachers. *Journal of Physics Teacher Education Online*, 2 (4), 3-8.

Nakleh, Mary B. (1994) Students' Model of Matter in the Context of Acid Base Chemistry. *Journal of Chemical Education*, 71 (6), 495-499.

Nakleh, Mary B. (1992) Why Some Students Don't Learn Chemistry. *Journal of Chemical Education*, 69 (3), 191-196.

Nicoll, G. (2001) A report of undergraduates' bonding misconceptions. *International Journal of Science Education*, 23 (7), 707-730.

Shimshon, N. and Nussbaum J. (1978) Junior High School Pupils' Understanding of the Particulate Nature of Matter: An Interview Study. *Science Education*, 62 (3), 273-281.

Shimshon, N. and Nussbaum J. (1981) Pupils' Understanding of the Particulate Nature of Matter: A Cross-Age Study. *Science Education*, 65 (2), 187-196.

Yalın İ. (1999). *Öğretim Teknolojileri ve Materyal Geliştirme*. Ankara: Nobel Yayın Dağıtım.

CHAPTER 6

DESIGN OF AN ARTIFICIAL INTELLIGENCE-SUPPORTED TEMPERATURE-CONTROLLED ARDUINO UNO pH METER FOR STUDENT LABORATORIES

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INTRODUCTION

The availability of advanced experimental equipment and students' capacity to use these resources effectively serves as a cornerstone in scientific education and research (Hofstein & Lunetta, 2004). This is important for improving students' understanding of scientific concepts and enables researchers to conduct pioneering works. However, the high costs of modern laboratory equipment make it difficult for many educational institutions to procure these resources widely, reducing the effectiveness of experiential learning processes (Schweingruber, Hilton & Singer, 2006). In particular, these limitations severely restrict students' opportunities to develop scientific comprehension and engage in experiential learning in developing regions (Hofstein & Lunetta, 2004).

According to Kolb's experiential learning theory, the learning process consists of a four-stage iterative cycle: acquiring concrete experiences, observation and data collection, forming abstract concepts and generalizations, and conducting new tests to verify these concepts (Kolb, 1984). This model emphasizes the importance of testing abstract concepts through concrete experiences to ensure their validity. Students should develop concepts that they can integrate into logical theories by observing and reflecting on their experiences, and they should be able to use these theories in problem-solving and decision-making stages. Individuals perceive information by feeling or thinking and process it by observing or doing.

For students to effectively experience this learning cycle, active participation in repeating experiences, data collection, analysis, and feedback processes are re-

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In real-world applications, the pH values of natural water samples and various food products such as orange juice, vinegar, and yogurt were measured to assess the device's practical performance. The results indicated that the device exhibits consistent performance with low error percentages and high repeatability, making it capable of providing reliable measurements beyond controlled laboratory environments.

Using AI tools in the code development process accelerated programming, reduced potential errors, and optimized system performance. This approach offers an educational advantage by enabling students to gain experience with modern technologies such as microcontroller programming and AI applications.

Despite the device's successful outcomes, certain limitations exist. The device's accuracy may not fully match the high-end commercial pH meters required for advanced research applications. Regular calibration and maintenance are necessary to maintain long-term accuracy. Future studies are recommended to enhance sensor quality, develop more precise calibration protocols, and expand the device to include additional parameters such as conductivity or dissolved oxygen measurements.

In conclusion, the developed AI-supported, temperature-controlled Arduino UNO pH meter provides a cost-effective, reliable, and educational tool for student laboratories. This device bridges the gap between theoretical concepts and practical applications, allowing students to gain experience in analytical chemistry and modern technological tools. By offering an accessible alternative to expensive commercial instruments, this project has the potential to support experiential learning and promote innovation in educational environments.

REFERENCES

Abrahams, I., & Millar, R. (2008). Does practical work really work? A study of the effectiveness of practical work as a teaching and learning method in school science. *International journal of science education*, *30*(14), 1945-1969.

Dochshanov, A. M., & Tramonti, M. (2023). The Design and Implementation of an Open-source Programmable Bot for Educational Purposes. *Digital Presentation and Preservation of Cultural and Scientific Heritage*, *13*, 289-298.

Guzmán-Fernández, M., Zambrano de la Torre, M., Ortega-Sigala, J., Guzmán-Valdivia, C., Galvan-Tejeda, J. I., Crúz-Domínguez, O., ... & Durán-Muñoz, H. A. (2021). Arduino: A Novel Solution to the Problem of High-Cost Experimental Equipment in Higher Education. *Experimental Techniques*, 1-13.

Haefner, N., Wincent, J., Parida, V., & Gassmann, O. (2021). Artificial intelligence and innovation management: A review, framework, and research agenda. *Technological Forecasting and Social Change*, *162*, 120392.

Hofstein, A., & Lunetta, V. N. (2004). The laboratory in science education: Foundations for the twenty-first century. *Science education*, *88*(1), 28-54.

Huang, X., & Qiao, C. (2024). Enhancing computational thinking skills through artificial intelli-

gence education at a STEAM high school. *Science & Education*, *33*(2), 383-403.

Irawan, Y., Febriani, A., Wahyuni, R., & Devis, Y. (2021). Water quality measurement and filtering tools using Arduino Uno, PH sensor, and TDS meter sensor. *Journal of Robotics and Control (JRC)*, *2*(5), 357-362.

Ismailov, A. S., & Jo'Rayev, Z. B. (2022). Study of Arduino microcontroller board. *Science and Education*, *3*(3), 172–179.

Jawad, H. M., Ahmed, S. S., Jassim, M. M., & Korniichuk, B. (2024, April). Design a pH Meter Using Arduino. In *2024, 35th Conference of Open Innovations Association (FRUCT)* (pp. 307–318). IEEE.

Jin, H., Qin, Y., Pan, S., Alam, A. U., Dong, S., Ghosh, R., & Deen, M. J. (2018). An open-source, low-cost wireless potentiometric instrument for pH determination experiments.

Julian, J., Wahyuni, F., & Ulhaq, F. D. (2023). Reliability Analysis of pH Measurement on TLC4502 with E201C Electrodes based on ATmega328P Microcontroller: Approach to Analysis of Variation with ANOVA. *ELKHA: Jurnal Teknik Elektro*, *15*(1), 32-40.

Kang, S. J., Yeo, H. W., & Yoon, J. (2019). Applying Chemistry Knowledge to Code, Construct, and Demonstrate an Arduino–Carbon Dioxide Fountain. *Journal of Chemical Education*, *96*(2), 313-316.

Kibirige, I., & Tsamago, H. E. (2019). Grade 10 learners' science conceptual development using computer simulations. *Eurasia Journal of Mathematics, Science and Technology Education*, *15*(7), em1717.

Kitcharoen, P., Howimanporn, S., & Chookaew, S. (2023). Review Process to Investigate Trends of Using Arduino to Enhance AI Study. In *31st International Conference on Computers in Education, ICCE* (pp. 448–455).

Kolb, D. (1984). *Experiential learning: Experience as the source of learning and development*.New Jersey: Prentice-Hall.

Linn, M. C., Bell, P., & Davis, E. A. (2004). Specific design principles: Elaborating the scaffolded knowledge integration framework. In M. Linn, E. A. Davis & P. Bell (Eds.), Internet environments for science education (pp. 315- 341). Mahwah, NJ: Lawrence Erlbaum Associates.

Morchid, A., El Alaoui, M., El Alami, R., Qjidaa, H., El Khadiri, K., & Mehdaoui, Y. (2021, January). Design and realization of a fire safety system for controlling and monitoring a siren using Arduino Uno. In *International Conference on Digital Technologies and Applications* (pp. 433-445). Cham: Springer International Publishing.

Mukaka MM (2012). Statistics Corner: A guide to the appropriate use of correlation coefficient in medical research. Malawi Med J 24:69–71

Oh, P. K., & Kang, S. J. (2021). Integrating Artificial Intelligence to Chemistry Experiment: Carbon Dioxide Fountain. *Journal of Chemical Education*, *98*(7), 2376-2380.

Orellana, J. L. R., & Chang, O. (2021). Artificial intelligence-controlled pole balancing using an Arduino board. *Revista Tecnológica-ESPOL*, *33*(2), 189-204.

Papadopoulos, N. J., & Jannakoudakis, A. (2016). A chemical instrumentation course on microcontrollers and op amps. Construction of a pH meter. *Journal of Chemical Education*, *93*(7), 1323-1325.

Polat, M. Y., Beyaz, A., & Çilingir, İ. (2020). Development of a Low-Cost pH Meter for Liquid Chemical Fertilizers. *Turkish Journal of Agriculture-Food Science and Technology*, *8*(4), 840-846.

Qutieshat, A., Aouididi, R., & Arfaoui, R. (2019). Design and construction of a low-cost Arduino-based pH sensor for the visually impaired using universal pH paper.

Sadraey, M. H. (2024). Microcontroller Boards. In *Unmanned Aircraft Design: A Review of Fundamentals* (pp. 151–169). Cham: Springer International Publishing.

Sanusi, I. T., Agbo, F. J., Dada, O. A., Yunusa, A. A., Aruleba, K. D., Obaido, G., ... & Oyelere, S. S. (2024). Stakeholders' insights on artificial intelligence education: Perspectives of teachers, students, and policymakers. *Computers and Education Open*, *7*, 100212.

Schweingruber, H. A., Hilton, M. L., & Singer, S. R. (Eds.). (2006). *America's lab report: Investigations in high school science*. National Academies Press.

Skoog, D. A., Holler, F. J., & Crouch, S. R. (2018). Principles of instrumental analysis (7th ed.). Cengage Learning.

Skoog, D. A., West, D. M., Holler, F. J., & Crouch, S. R. (2021). Fundamentals of Analytical Chemistry (10th ed.). Cengage Learning.

Soni, G. (2022, February). Implementation of LM35 interfacing of a temperature sensor with Arduino using LabVIEW 2015. In *2022 IEEE Delhi Section Conference (DELCON)* (pp. 1–3). IEEE.

Soong, R., Agmata, K., Doyle, T., Jenne, A., Adamo, T., & Simpson, A. (2018). Combining the maker movement with accessibility needs in an undergraduate laboratory: a cost-effective multipurpose text-to-speech Universal Chemistry Sensor Hub (MUCSH) for Students with Disabilities.

Tay, K. S., & Eng, J. L. (2024). Integrating Maker Education into the Research Project of Undergraduate Chemistry Program: Low-Cost Arduino-Based 3D Printed Autotitrator. *Journal of Chemical Education*.

Wu, Y., Chen, Y., & Cheng, Y. (2024). Building an Arduino-Based Open-Source Programmable Multichannel Syringe Pump: A Useful Tool for Fluid Delivery in Microfluidics and Flow Chemistry. *Journal of Chemical Education*, *101*(5), 1951-1958.

Yang, W., Hu, X., Yeter, I. H., Su, J., Yang, Y., & Lee, J. C. K. (2024). Artificial intelligence education for young children: A case study of technology-enhanced embodied learning. *Journal of Computer Assisted Learning*, *40*(2), 465-477.

Yue, M., Jong, M. S. Y., & Dai, Y. (2022). Pedagogical design of K-12 artificial intelligence education: A systematic review. *Sustainability*, *14*(23), 15620.

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). A systematic review of research on artificial intelligence applications in higher education–where are the educators? *International Journal of Educational Technology in Higher Education*, *16*(1), 1-27.

CHAPTER 7

EDUCATION FOR SUSTAINABLE DEVELOPMENT: AN EVALUATION OF EDUCATIONAL POLICIES IN TURKEY

Beril SALMAN AKIN [1]

INTRODUCTION

Sustainable Development is an approach that aims to meet present needs without compromising the ability of future generations to meet their own needs. The environmental degradation, depletion of natural resources, and growing social and economic inequalities caused by human activities make this approach essential. Education plays a crucial role in raising sustainability awareness among individuals and is seen as a critical tool for achieving sustainable Development in line with the United Nations' Sustainable Development Goals (SDGs). The process began with the Stockholm Conference in 1972, continued with the Rio Summit in 1992, and gained significant momentum worldwide with the United Nations Decade of Education for Sustainable Development from 2005 to 2014. During this period, education expanded to increase environmental awareness and encompass social justice and economic sustainability. Education for Sustainable Development in Turkey has made notable progress in recent years. The Ministry of National Education (MoNE) implemented curriculum revisions in 2018 and 2024, integrating sustainability-themed topics such as environmental awareness, recycling, energy efficiency, and climate change into various subjects from primary to high school. These themes are addressed in subjects like Science, Social Studies, and Geography, while non-governmental organizations also work to raise awareness through educational projects and workshops.

Examining how Turkey's education policies align with sustainable development goals is crucial for understanding the effectiveness of domestic reforms and the extent to which they meet international standards. This research explores how

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ently and holistically. Students should be provided with a continuous pathway for learning about sustainability throughout their Education, with these topics being addressed in a complementary way.

Given technological advancements, the widespread use of digital education platforms offers significant opportunities for sustainable development education. In Turkey, remote learning systems should be more actively utilized to reach broader audiences on environmental education and sustainability topics.

Turkey's signing of the Paris Climate Agreement and other international environmental commitments underscores the importance of sustainable development education. Within this framework, students should be given opportunities to gain a broader global perspective and contribute to climate action.

All assessments indicate the need for an educational model where students are not limited to theoretical knowledge but also develop sustainable behaviors. Therefore, efforts in curriculum development, teacher training, community awareness projects, and digital tools will accelerate Turkey's progress toward achieving sustainable development goals.

REFERENCES

Bianchi, G., Pisiotis, U., Cabrera Giraldez, M. (2022). *GreenComp – Avrupa sürdürülebilirlik yetkinlik çerçevesi. Bacigalupo, M., Punie, Y (Eds.). EUR 30955 EN*. Avrupa Birliği Yayın Ofisi. DOI:10.2760/13286, JRC128040.

Brundtland Report (1987). Report of the World Commission on Environment and Development: Our Common Future Transmitted to the General Assembly as an Annex to document A/42/427- Development and International Cooperation: Environment.

Elgin, İ., (2012). Sürdürülebilirlik İçin Eğitim, Alternatif Eğitim Yöntemleri, Sorunları ve Uygulamaya İlişkin Değerlendirmeler. Ankara Üniversitesi, Sosyal Çevre Bilimleri Anabilim Dalı, Doktora Tezi.

Hassan, A., Noordin, T.A. and Sulaiman, S. (2010). "The status on the level of environmental awareness in the concept of sustainable development amongst secondary student," Procedia Social and Behavioral Science, Vol. 2, pp. 1276–1280.

Kopnina, H. (2012). "Education for sustainable development (ESD): the turn away from 'environment' in environmental Education?" Environmental Education Research, Vol. 18 No. 5, pp. 699–717.

Laroche, M., Bergeron, J. and Barbaro-Forleo, G. (2001). "Targeting consumers willing to pay more for environmentally friendly products," *Journal of Consumer Marketing*, Vol. 18 No. 6, pp. 503-520.

Loukola, M. (2001). Education For Sustainable Development In Schools, Education for Sustainable Development In Finland, Ministry of Education, An Agenda 21 for Education for Sustainable Development In the Baltic Sea Region -Baltic 21E" Working Group Report.

McKeown, R. (2002). Education for Sustainable Development Tool Kit, Center for Geography and Environmental Education, University of Tennessee, available at www.esdtoolkit.org.

Miller, E., Buys, L., ve Bell, L. (2009) "Living Smart Homes a Pilot Australian Sustainability Education Programme," Journal of Education For Sustainable Development, 3:2: 159–170.

Milli Eğitim Bakanlığı Müfredatı (2024). Öğretim Programlarını İzleme ve Değerlendirme Programı. https://mufredat.meb.gov.tr/programlar.aspx.

Palmer, J.A. (1998). *Environmental Education in the 21st Century*: Theory Practice, Progress and Promise, Routledge, New York, NY.

Shephard, K. (2008). "Higher education for sustainability: seeking affective learning outcomes", International Journal of Sustainability in Higher Education, Vol. 9 No. 1, pp. 87–98.

Shaw, R., Sakurai, A., Oikawa, Y. (2021). New Realization of Disaster Risk Reduction Education in the Context of a Global Pandemic: Lessons from Japan.Int J Disaster Risk Sci., http://www.ijdrs.com/.

Scott, W. & Oulton, C. (1998). "Environmental values education: an exploration of its role in the school curriculum", Journal of Moral Education, Vol. 27 No. 2, pp. 209–224.

United Nations (2015). United Nations Sustainable Development Summit 2015. https://sustainabledevelopment.u.n.org/post2015/summit.

Uitto, A., Juuti, K., Lavonen, J., Byman, R. and Meisalo, V. (2011). "Secondary school student's interests, attitudes and values concerning school science related to environmental issues in Finland," Environmental Education Research, Vol. 17 No. 2, pp. 167-186.

UNECE (2003), "Draft UNECE strategy for education for sustainable development," CEP/AC.13/2004/3.

UNESCO (1992), UN Conference on Environment and Development: Agenda 21, UNESCO, Switzerland.

UNESCO (2004), Education for Sustainable Development: United Nations Decade 2005-2014, UNESCO, Paris.

UNESCO (2009), "Bonn declaration," available at: http://unesdoc.unesco.org/images/0018/001850/.

WCDE (1987). Report of the World Commission on Environment and Development https://digitallibrary.un.org/searchent.

CHAPTER 8

LOOKING INTO A MIRROR HELD UP TO JARRING REALITY: THE DEEP IMPRINTS OF POVERTY IN CHILDREN'S POETRY

Gökçe DEMİRYÜREK [1]

INTRODUCTION

Although poetry is perhaps the oldest literary genre, the lack of a clear and comprehensive definition of poetry stems from its unique characteristics in both form and content. In form, the poems are an extension of the lullabies and nursery rhymes that evoke childhood memories, a calm and familiar harbor with its elements of harmony and rhythm, and a series of associations that correspond to different experiences for each reader with the emotional load in its content. That is why there are many different definitions of poetry. One of the best known is Coleridge's definition: "The best words in the best order" (Phillis, 2003). While Coleridge focused on form in this definition, another well-known definition refers to content and emotional load by saying "the art of saying much in few words". It is not possible to say that children's poetry has a separate definition from poems written for adults. The distinction is the expression "choosing children as the target audience" or "suitability for the child" (Sever, 2008). Rather than the definitions of adult and children's poetry, it should be a priority to emphasize the power of poetry and enable children to benefit from this magical genre. Because in order to raise children who are peaceful and appreciate literature, it is necessary to teach them to love and miss poetry (Rozsak, 2013).

In today's complex and turbulent world, poetry serves as a reminder of our human condition. We see the most sincere, cleanest and farthest from falsehood in poems. The power of poems is undeniable, not only in conveying emotions but also in conveying ignored realities. What about children's poems? Although there are many different opinions on what the purpose of children's poems is or how children's poems should be, a common judgment is that children's poems direct

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highlight how poverty undermines these rights and emphasize the role of society in ensuring them. These commonalities show the depth and diversity of the poems' perspectives on poverty. While each of the poets addresses poverty from a different perspective, they convey a common message: That every child has equal rights and that poverty should not prevent the realization of these rights.

REFERENCES

Aksan, D. (2011). *Poetry analysis with examples from the Republican period to today.* Bilgi Publishing House.

Atıf Erten, A. (2022). Refik Durbaş's contributions to Turkish children's literature. *The Journal of Turk-Islam World Social Studies, 9*(33), 197-206. https://doi.org/ 10.29228/TIDSAD.62906

Aykaç, M. (2011). *The effect of creative drama activities on children's narration skills set up with child literature texts in Turkish teaching* [Doctoral Thesis, Ankara University]. YÖK Thesis Center.

Balık, M. (2017). War and militarizm in poems Süreyya Berfe. *Journal of Faculty of Letters, 2*(2), 3-18.

Bayat, N., & Çetinkaya, G. (2017). Children's poetry with regard to poetic structure. *Mediterranean Journal of Humanities, 7*(1), 67-76.

Berfe, S. (2014). *Çocukça.* Can Child Publishing.

Brooks-Gunn, J., & Duncan, G. J. (1997). The effects of poverty on children. *The future of children,* 55-71.

Büyükmeriç, E. (2019). *Kanatlı düşler.* Tudem Publishing House.

Cooper, H. (2006). A voice, a song, and a cry: Ventriloquizing the poor in poems by Lady Wilde, Thomas Hood, and Elizabeth Barrett Browning. *Studies in Browning and His Circle,* 27, 26-40.

Durbaş, R. (2016). *Nar düştü kar üstüne.* Can Child Publishing.

Durmuş, G. (2023). Reflections of social realistic poetics in Süreyya Berfe's first two poetry books. *Söylem Journal of Philology, 8*(3), 650-671. https://doi.org/10.29110/soylemdergi.1353889

Ertuş, A. (2018). Poverty in Rıfat Ilgaz's work of Soluk Soluğa (out of breath). *The Journal of Academic Social Science Studies* (73), 29-40.

Foster, V. (2012). What if? The use of poetry to promote social justice. *Social Work Education, 31*(6), 742-755.

Kuş, O. (2022). The use of content analysis and text mining in communication studies. *Pamukkale University Journal of Social Sciences Institute,* (51), 177-191. https://doi.org/10.30794/pausbed.1099169

Lüle, E. (2007). Evaluation of seven juvenile books for their convenience to the principles of juvenile literature. *Inonu University Journal of the Faculty of Education, 8*(13), 17-30.

Mercanoğlu, S. (2008). *Güzel günler kitabı.* Can Child Publishing.

Merriam, S. B. (2013). Qualitative Research: A Guide to Design and Implementation (3rd Edition, Translated by: S. Turan). Nobel Publishing.

Oğuzkan, F. (2001). *Children literature.* Anı Publishing.

Özdemir, A., & Kaya, A. İ. (2023). Examination of Refik Durbaş›s children›s poems in terms of content. *RumeliDE Journal of Language and Literature Studies,* (37), 448-468. https://doi.org/10.29000/rumelide.1405761

Phillips, R. (2003). The best words in the best order [Review of Solving for X; Middle Earth; Contradictions; Open Shutters; Burning the Aspern Papers; The Palace of Ashes; Beyond Silence, by R. B. Shaw, Henri Cole, A. Corn, Mary Jo Salter, J. Drury, Sherry Fairchok, & D. Hoffman]. *The Hudson Review, 56*(3), 543–548. https://doi.org/10.2307/3852704

Rosenbergova-Zemkova, B. D. (2011). Contemporary issues in modern children's poetry [Diploma thesis]. Masaryk Unıversıty Brno.

Roszak, J. (2013). Words and herbs. *Psychology, 12*(2), 25-38.

Salmeron Gomez, D., Engilbertsdottir, S., Cuesta Leiva, J. A., Newhouse, D., & Stewart, D. (2023). *Global trends in child monetary poverty according to international poverty lines.* Policy Research Working Papers; 10525. © World Bank, Washington, DC. http://hdl.handle.net/10986/40364 License: CC BY 3.0 IGO."

Sevim, G. (2022). Cahit Zarifoğlu's poetics and poetic language. *Turkish Studies-Language & Literature, 17*(2).

Sever, S. (2008). *Children and literature.* Tudem Publishing.

Şen, C. (2017). The first academic book on Süreyya Berfe and his poetry: "Life and Poetry" Süreyya Berfe›s poetry world. *Journal of Turkish Language and Literature, 3*(3), 211-213.

Tekin, A., & Kaya, E. (2012). Content analysis of websites concerning alternative medicine with cancer. *Mehmet Akif Ersoy University Journal of Social Sciences Institute,* (6), 14-34.

Victora, C. G., Hartwig, F. P., Vidaletti, L. P., Martorell, R., Osmond, C., Richter, L. M., ... & Black, R. E. (2022). Effects of early-life poverty on health and human capital in children and adolescents: analyses of national surveys and birth cohort studies in LMICs. *The Lancet, 399*(10336), 1741-1752.

Ulukök Yıldırım, Ş. (2023). Review of researches on pedagogical content knowledge published in ESERA (2009-2019) conference books. *International Journal of Progressive Education, 19*(2).

Ulukök Yıldırım, Ş. (2024). Trends in planetarium research: A bibliometric analysis. *Journal of National Education,* (241). https://doi.org/10.37669/milliegitim.1188601

Ulutaş, N., & Süphandağı, İ. (2013). Use of child image in Cahit Zarifoglu and Paul Eluard's poems. *Electronic Turkish Studies, 8*(4).

Wiseman, A. M., & Wissman, K. (2012). "*People suffer more than you think*": *Witnessing trauma in children's poetry.* 61st Yearbook of the Literacy Research Association, 119.

Zarifoğlu, C. (2015). *Gülücük.* Beyan Publishing.

CHAPTER 9

PRE-SERVICE EFL TEACHERS' ENGAGEMENT WITH SUSTAINABLE DEVELOPMENT GOALS THROUGH RECYCLED MATERIALS

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INTRODUCTION

In recent years, sustainability has become more and more a priority to cultivate global citizens, especially within an educational context. The central problem is that neither teachers nor pupils are aware of the Sustainable Development Goals. This state of affairs constitutes a grave challenge in today's educational environment, where awareness of these issues is crucial for making a successful response to global sustainability imperatives. The research has a broader value with respect to environmental sustainability within educational settings regarding the examination of sustainability practices' alignment with the global agenda of the SDGs. The study adds to the insights on pedagogical innovation in foreign language teaching and a way for educators to take concrete steps toward reducing their footprint. This current study points out both the relationship between education and sustainability, as well as the contribution of educational institutions to the SDGs.

The main purpose of this study is to investigate pre-service English language teachers' awareness, perceptions, and attitudes towards the inclusion of recycled course materials in English language teaching and their potential contribution to the SDGs. The general aims of this project are to find out what pre-service EFL teachers think about the role of recycled course materials in achieving the SDGs, to assess their views on the use of these materials in teaching English to young learners (TEYL), and to determine how much awareness they have on this issue.

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While this study adds to the already published works on sustainable education, it also points to areas of further research. Future studies can be designed to ascertain how logistic barriers to using recycled materials can be overcome and the long-term implications of infusing SDGs across different learning environments. This would help educators tap into the full potential of sustainable practices toward creating a global generation of conscious, linguistically proficient learners.

REFERENCES

Acar, H., & Akhan, N. E. (2023). A practical example for pre-service teachers for a more qualified sustainable development education. *South African Journal of Education*, *43*(1), S1-S16. https://doi.org/10.15700/saje.v43ns2a229

Aksan, Z., & Çelikler, D. (2020). Creating awareness of pre-service science teachers for sustainable development about waste recycling. *International Electronic Journal of Environmental Education*, *10*(2), 147-166.

Arikan, A., & Zorba, M. G. (2024). Raising pre-service English language teachers' awareness of sustainable development goals through literary texts. *International Journal of Sustainability in Higher Education*. Vol. 25 No. 8, pp. 1681-1695. https://doi.org/10.1108/IJSHE-06-2023-0256

Beka, A., & Ciani, A. (2015). Promoting education for sustainable development at the University of Prishtina, Kosovo. *Integrating Sustainability Thinking in Science and Engineering Curricula: Innovative Approaches, Methods and Tools*, 139-151. https://doi.org/10.1007/978-3-319-09474-8_11

Bekteshi, E., & Xhaferi, B. (2020). Learning about sustainable development goals through English language teaching. *Research in Social Sciences and Technology*, *5*(3), 78-94. https://doi.org/10.46303/ressat.05.03.4

Birt, L., Scott, S., Cavers, D., Campbell, C., & Walter, F. (2016). Member checking: A tool to enhance trustworthiness or merely a nod to validation?. *Qualitative Health Research*, *26*(13), 1802-1811. https://doi.org/10.1177/1049732316654870

Bontempi, E., Sorrentino, G. P., Zanoletti, A., Alessandri, I., Depero, L. E., & Caneschi, A. (2021). Sustainable materials and their contribution to the sustainable development goals (SDGs): A critical review based on an Italian example. *Molecules*, *26*(5), 1407. https://doi.org/10.3390/molecules26051407

Bowden, R. (2011). Teaching English for Sustainability. *Journal of Nelta, 15*(1-2), 16-21.

Carlson, J. A. (2010). Avoiding traps in member checking. *Qualitative Report*, *15*(5), 1102-1113. https://doi.org/10.46743/2160-3715/2010.1332

Cernev, T., & Fenner, R. (2020). The importance of achieving foundational Sustainable Development Goals in reducing global risk. *Futures*, *115*, 102492. https://doi.org/10.1016/j.futures.2019.102492

Creswell, J. W., & Miller, D. L. (2000). Determining validity in qualitative inquiry. *Theory into practice*, *39*(3), 124-130. https://doi.org/10.1207/s15430421tip3903_2

Demirci, C., & Çınar, S. O. (2021). Use of educational games with recycled materials in English teaching. *European Journal of Education Studies, 9*(1), 29-43. http://dx.doi.org/10.46827/ejes.v9i1.4087

Dewantari, F. (2021). The use of recycled objects as English teaching media for young learners. *The Art of Teaching English as a Foreign Language, 1*(2), 71-74. https://doi.org/10.36663/tatefl.v2i1.106

Hoballah, A., & Averous, S. (2015). Ensure sustainable consumption and production patterns. *UN Chronicle*, *51*(4), 28-29. https://doi.org/10.18356/4bd7f86c-en

Karpudewan, M., Ismail, Z., & Mohamed, N. (2013). Pre-service teachers' understanding and awareness of sustainable development concepts and traditional environmental concepts. *Asia*

Pacific Journal of Educators and Education, 28, 117–130. Retrieved from https://eprints.usm.my/34719/1/apjee28_2013_art8_117_130.pdf

Kobayashi, T., & Nakajima, L. (2021). Sustainable development goals for advanced materials provided by industrial wastes and biomass sources. *Green and Sustainable Chemistry, 28*, 100439. https://doi.org/10.1016/j.cogsc.2020.100439

Kwee, C.T. (2021). I want to teach sustainable development in my English classroom: A case study of incorporating sustainable development goals in English teaching. *Sustainability, 13*(8), 4195. https://doi.org/10.3390/su13084195

Lietz, C. A., Langer, C. L., & Furman, R. (2006). Establishing trustworthiness in qualitative research in social work: Implications from a study regarding spirituality. *Qualitative Social Work*, *5*(4), 441-458. https://doi.org/10.1177/1473325006070288

Loh, J. (2013). Inquiry into issues of trustworthiness and quality in narrative studies: A perspective. *Qualitative Report*, *18*(65). 1-15. Retrieved from http://www.nova.edu/ssss/QR/QR18/loh65.pdf

Rahayuningsih, D. (2016). Student teachers' challenges in developing teaching materials during teaching practicum in vocational school. *Journal of English and Education*, *4*(2), 24-34. Retrieved from https://core.ac.uk/download/pdf/295400877.pdf

Shenton, A. K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information*, *22*(2), 63-75. https://doi.org/10.3233/EFI-2004-22201

Sinakou, E., Donche, V., Boeve-de Pauw, J., & Van Petegem, P. (2019). Designing powerful learning environments in education for sustainable development: A conceptual framework. *Sustainability*, *11*(21), 5994. https://doi.org/10.3390/su11215994

Yeboah, R., Asante, E.A., & Opoku-Asare, N.A. (2016). Teaching interactive art lessons with recycled waste materials as instructional resources. *Journal of Education and Practice, 7*(14), 38-59.

Yılmaz Fındık, L., Bayram, I., & Canaran, Ö. (2021). Pre-service English language teachers' conceptions of sustainable development: A case from Turkish higher education context. *International Journal of Sustainability in Higher Education*, *22*(2), 423-456. https://doi.org/10.1108/ijshe-06-2020-0202

CHAPTER 10

REVIEWING GAME-BASED LEARNING RESEARCH IN SCIENCE EDUCATION WITH BIBLIOMETRIC ANALYSIS

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Duygu SÖNMEZ [2]

INTRODUCTION

Digitalization in education has radically transformed teaching methods and pedagogical approaches, leading to the adoption of innovative methods that make learning experiences more effective and motivating to support learners' acquisition of knowledge and skills. In this context, game-based learning (GBL) stands out as a learning method that aims to develop learners' cognitive, emotional, and social skills (Granic et al., 2014; Hartt et al., 2020; Mahendra et al., 2022; Plass et al., 2015). The ability of GBL to transform learning processes, especially in disciplines such as science, where abstract concepts are dense, makes this method even more valuable as a pedagogical tool in science education (Khan et al., 2017; Wang & Zheng, 2021).

Science education is crucial for fostering scientific and democratic values, enhancing individuals' scientific and democratic literacy, and driving technological advancements in society (Crandall, 2019; Grinis, 2019; Trna & Trnova, 2015). Especially in today's world, youth's interest in science and science related careers are desired more than ever thus requires a strong science education. Despite its importance, science education encounters numerous structural and pedagogical challenges. Fundamental problems such as insufficient teacher support, psychological (self-efficacy, anxiety, emotional dimensions) and physiological factors that negatively affect students' performance, and epistemological deficiencies hinder the effectiveness of science education (Martin et al., 2021; Wang et al., 2023).

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As with any other research, this study has some limitations. The analysis was limited to metadata and citation counts obtained from the WoS database. Moreover, only VOSviewer software was used in the bibliometric analysis process, and only articles published in English were included in the study. Other publications, such as book chapters and conference proceedings, were excluded from this analysis. Future studies can be conducted more broadly to overcome these limitations and include different databases (e.g., Scopus, Google Scholar). Various data visualization methods could be evaluated using alternative bibliometric analysis software (e.g., CiteSpace, Gephi). Furthermore, a broader perspective can be gained by including publications such as book chapters, theses, and conference proceedings. Research on GBL applications in different disciplines can also significantly contribute to the literature in this field.

REFERENCES

Chen, P.-Y., Hwang, G.-J., Yeh, S.-Y., Chen, Y.-T., Chen, T.-W., & Chien, C.-H. (2022). Three decades of game-based learning in science and mathematics education: An integrated bibliometric analysis and systematic review. *Journal of Computers in Education, 9*(1), 455–476. https://doi.org/10.1007/s40692-021-00210-y

Chiang, F. K., & Qin, L. (2018). A pilot study to assess the impacts of game-based construction learning, using Scratch, on students' multi-step equation-solving performance. *Interactive Learning Environments, 26*(6), 803–814. https://doi.org/10.1080/10494820.2017.1417397

Cooke, L. (2016, March). Metatuning: A pedagogical framework for a generative STEM education in game design-based learning. In *2016 IEEE Integrated STEM Education Conference (ISEC)* (pp. 207–214). IEEE.

Crandall, C. S. (2019). Science as dissent: The practical value of basic and applied science. *Journal of Social Issues, 75*(2), 630–641.

Demiryürek, G. (2023). A bibliometric view on values education studies in the international arena. *Problems of Education in the 21st Century*, *81*(1), 27-43.

Ekin, C. C., & Gul, A. (2022). Bibliometric analysis of game-based research in educational research. *International Journal of Technology in Education, 5*(3), 499–517.

Fellnhofer, K. (2019). Toward a taxonomy of entrepreneurship education research literature: A bibliometric mapping and visualization. *Educational Research Review, 27,* 28–55.

Granic, I., Lobel, A., & Engels, R. C. M. E. (2014). The benefits of playing video games. *American Psychologist, 69*(1), 66–78.

Grinis, I. (2019). The STEM requirements of "non-STEM" jobs: Evidence from UK online vacancy postings. *Economics of Education Review, 70,* 144–158.

Hartt, M., Hosseini, H., & Mostafapour, M. (2020). Game on: Exploring the effectiveness of game-based learning. *Planning Practice & Research, 35*(5), 589–604.

Honey, M. A., & Hilton, M. L. (2011). *Learning science through computer games.* National Academies Press.

Hung, C. Y., Sun, J. C. Y., & Yu, P. T. (2014). The benefits of a challenge: Student motivation and flow experience in tablet-PC-game-based learning. *Interactive Learning Environments, 23*(2), 172–190. https://doi.org/10.1080/10494820.2014.980275

Hwang, G.-J., & Chen, P.-Y. (2022). Interweaving gaming and educational technologies: Clustering and forecasting the trends of game-based learning research by bibliometric and visual analysis. *Entertainment Computing, 40,* 100459.

Khan, A., Ahmad, F. H., & Malik, M. M. (2017). Use of digital game-based learning and gamification

in secondary school science: The effect on student engagement, learning, and gender difference. *Education and Information Technologies, 22,* 2767–2804.

Lin, Y. H., & Hou, H. T. (2016). Exploring young children's performance on and acceptance of an educational scenario-based digital game for teaching route-planning strategies: A case study. *Interactive Learning Environments, 24*(8), 1967–1980. https://doi.org/10.1080/10494820.2015.1064635

Mahendra, H. H., Maftuh, B., & Dahliyana, A. S. E. P. (2022). Bibliometric analysis of publications about game-based learning in Scopus database using VOSviewer. *Journal of Engineering Science and Technology, 53,* 53–68.

Martin-Martin, A., Thelwall, M., Orduna-Malea, E., & Lopez-Cozar, E. D. (2021). Google Scholar, Microsoft Academic, Scopus, Dimensions, Web of Science, and OpenCitations' COCI: A multidisciplinary comparison of coverage via citations. *Scientometrics, 126*(2), 871–906.

Martin, A. J., Kennett, R., Pearson, J., Mansour, M., Papworth, B., & Malmberg, L. (2021). Challenge and threat appraisals in high school science: Investigating the roles of psychological and physiological factors. *Educational Psychology (Dorchester-on-Thames), 41*(5), 618–639.

Meluso, A., Zheng, M., Spires, H. A., & Lester, J. (2012). Enhancing learning through game-based interactions: Designing adaptive scaffolding to support middle school students in game-based learning environments. *Computers & Education, 58*(1), 1–10. https://doi.org/10.1016/j.compedu.2011.08.016

Plass, J. L., Homer, B. D., & Kinzer, C. K. (2015). Foundations of game-based learning. *Educational psychologist*, *50*(4), 258-283.

Scherer, R., Siddiq, F., & Tondeur, J. (2019). The technology acceptance model (TAM): A meta-analytic structural equation modeling approach to explaining teachers' adoption of digital technology in education. *Computers & Education, 128,* 13–35.

Sung, H. Y., & Hwang, G. J. (2013). A collaborative game-based learning approach to improving students' learning performance in science courses. *Computers & Education, 63,* 43–51. https://doi.org/10.1016/j.compedu.2012.11.019

Tonbuloğlu, B., & Tonbuloğlu, İ. (2023). Trends and patterns in blended learning research (1965–2022). *Education and Information Technologies, 28*(11), 13987–14018.

Trna, J., & Trnova, E. (2015). The current paradigms of science education and their expected impact on curriculum. *Procedia-Social and Behavioral Sciences, 197,* 271–277.

Ulukök, E. (2022). Mapping the intellectual structure of perceived overqualification research: A co-keyword and co-citation analysis. *Dumlupinar University Journal of Social Sciences, (74),* 54–74.

Ulukök, E., & Merdan, E. (2022). Laissez-faire leadership: A map of the field and a bibliometric analysis. *International Journal of Economics, Business, and Politics, 6*(2), 371–396.

Ulukök Yıldırım, Ş. (2024). Trends in planetarium research: A bibliometric analysis. *Journal of Millî Eğitim, 53*(241), 31- 56.

Ulukök Yıldırım, Ş., & Sönmez, D. (2024). A bibliometric look at eye-tracking research in video-based learning. *Van Yüzüncü Yıl University Journal of Education, 21*(2), 378–400. https://doi.org/10.33711/yyuefd.1378898

Van Eck, N. J., & Waltman, L. (2010, August 01). Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics, 84*(2), 523–538.

Verkijika, S. F., & De Wet, L. (2015). Using a brain-computer interface (BCI) in reducing math anxiety: Evidence from South Africa. *Computers & Education, 81,* 113–122. https://doi.org/10.1016/j.compedu.2014.10.018

Wang, B., Pan, S. Y., Ke, R. Y., Wang, K., & Wei, Y. M. (2014). An overview of climate change vulnerability: A bibliometric analysis based on Web of Science database. *Natural Hazards, 74*(3), 1649–1666. https://doi.org/10.1007/s11069-014-1260-y

Wang, M., & Zheng, X. (2021). Using game-based learning to support learning science: A study with middle school students. *The Asia-Pacific Education Researcher, 30*(2), 167–176.

Wang, S., Chen, Y., Lv, X., & Xu, J. (2023). Hot topics and frontier evolution of science education

research: A bibliometric mapping from 2001 to 2020. *Science & Education, 32*(3), 845–869.

Xu, H., Cheng, X., Wang, T., Wu, S., & Xiong, Y. (2022). Mapping neuroscience in the field of education through a bibliometric analysis. *Brain Sciences, 12*(11), 1454.

Xu, J., Duffy, B. M., & Duffy, V. G. (2021, July). Data mining in systematic reviews: A bibliometric analysis of game-based learning and distance learning. In *International Conference on Human-Computer Interaction* (pp. 343–354). Cham: Springer International Publishing.

Zeng, R., & Chini, A. (2017). A review of research on embodied energy of buildings using bibliometric analysis. *Energy and Buildings, 155,* 172–184.

CHAPTER 11

TAXONOMY APPLICATIONS IN COASTAL ECOSYSTEMS: SCIENTIFIC RESULTS AND EVALUATION OF PROJECT-BASED LEARNING METHOD

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INTRODUCTION

Learning is personal, and each person learns differently (Cevizci, 2013). Today, social structure, information, communication, and education are all changing and evolving in parallel with the advancements in technology. Individual characteristics, needs, and expectations have consequently become inevitable, as have changes to educational activities (Yalın, 2017). Instead of producing passive and rote learners who are not left behind the technological advancements of today, the educational system has a responsibility to produce individuals who can learn, conduct research, and are able to evaluate and synthesize the knowledge they acquire (Maden et al. 2011). In the real world, educational systems aim for a student model who finds the information on his own and can also choose and extract the necessary information from an enormous amount of information, rather than one who finds the information ready and follows a teacher (Tunca et al, 2015).

Today, it is evident that the majority of nations seek to produce people who can think, comprehend, question, solve problems, and generate information in order to become contemporary societies. With the simple teaching approach that instructors typically use, which involves transmitting only the knowledge that the teacher has generated and presented to the student, it is impossible to expect pupils to acquire qualified thinking skills like the ability to evaluate and synthesize

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REFERENCES

Akçöltekin, A. (2016). Investigation of the effects of trainings on the development of high school teachers' attitudes about scientific researches and project competitions. *Educational Sciences: Theory & Practice, 16* (4), 1349-1380.

Akçöltekin, A., & Engin, A., O. (2019). Investigation of Self-Sufficiency Levels of High School Teachers in Terms of Participation in Project Competitions as Consultants, *Inonu University Journal of the Faculty of Education, 20* (1), 208-219. DOI: 10.17679/inuefd.429812

Arı, A. (2012). Öğretmen Görüşlerine Göre İsviçre (Basel) ve Türkiye İlköğretim Programlarının Karşılaştırılması: Bir Durum Çalışması. *Eskişehir Osmangazi Üniversitesi Sosyal Bilimler Dergisi 13* (1), 119-139.

Artvinli, E. Çetintaş, H., Terzi, İ. (2020). TÜBİTAK Ortaokul Öğrencileri Araştırma Projelerinin Bilimsel Danışmanlık Süreci Yönetimi: Fen Bilimleri Örneği. *International Journal of Active Learning (IJAL), 5* (2), 86-126

Asilsoy, Ö. (2007). *Biyoloji Öğretmenleri İçin Proje Tabanlı Öğrenme Yaklaşımı Konulu Bir Hizmet İçi Eğitim Kurs Programı Geliştirilmesi ve Etkililiğinin Araştırılması*. Doktora tezi, Karadeniz Teknik Üniversitesi Fen Bilimleri Enstitüsü.

Baki, A., Bütüner, S. Ö. (2009). Kırsal kesimdeki bir ilköğretim okulunda proje yürütme sürecinden yansımalar. *İlköğretim Online, 8* (1), 146-158

Balcı, S. (2013). Tablet Pc Destekli Türkçe Öğretiminin Temel Dil Becerilerine Etkisini Belirlemeye Yönelik Ölçek Çalışması. *Electronic Turkish Studies 8* (8), 855-870.

Baş, G. (2012). İlköğretim Öğrencilerinin Yapılandırmacı Öğrenme Ortamına İlişkin Algılarının Farklı Değişkenler Açısından Değerlendirilmesi. *Eğitim ve Öğretim Araştırmaları Dergisi*, 203-215.

Bandura, A. (1982). Self-efficacy mechanism in human agency. *American Psychologist, 37*, 122-147.

Balcı, S. (2013). Tablet Pc Destekli Türkçe Öğretiminin Temel Dil Becerilerine Etkisini Belirlemeye Yönelik Ölçek Çalışması. *Electronic Turkish Studies 8* (8), 855-870.

Boss, S. and Krauss, J. (2007). *Re-inveting project-based learning*. Washington, DC: ISTE.

Cevizci, H. (2013). Patlatma İçin Yeni Bir Stemming Uygulaması: Bir Vaka Çalışması, *Rem: Revista Escola De Minas 66* (4): 513-519.

Khalid, A., Azeem, M. (2012). Yapılandırmacı Geleneksel vs: Öğretmen Eğitiminde Etkili Öğretim Yaklaşımı. *Uluslararası İnsan ve Toplum Bilimleri Dergisi 2* (5), 170-177

Korkmaz, H. & Kaptan, F. (2001). Fen eğitiminde proje tabanlı öğrenme yaklaşımı. *Hacettepe Üniversitesi, Eğitim Fakültesi Dergisi, 20,* 193-200

Krajcik, J., & Blumenfeld, P. (2006). *19. Project-Based Learning. In The Cambridge Handbook of the Learning Sciences* (pp. 317-333). New York: Cambridge University Press.

Kurbanoğlu, S. (2010). Bilgi Okuryazarlığı: Kavramsal Bir Analiz. *Türk Kütüphaneciliği 24* (4), 723-747.

Küşük, S. (2020). *Proje Danışmanlığı Eğitiminin Biyoloji Lisans Öğrencilerinin Proje Yazma ve Yürütme Becerilerine Etkisi*. Yüksek lisans tezi, Gazi Üniversitesi Eğitim Bilimleri Enstitüsü

Maden, S., Durukan, E., Akbaş, E. (2011). "İlköğretim Öğretmenlerinin Öğrenci Merkezli Öğretime Yönelik Algıları", *Mustafa Kemal University Journal of Social Sciences Institute 8* (6), 255-269.

Moursund, D. (2003). *Project-based learning using ınformation technology*, Second edition. Eugene, OR:ISTE

Mutlu, F., & Yıldız Fidan, N. (2018). Fen bilimleri ve sınıf öğretmenlerinin proje tabanlı öğretim yapabilme özyeterlilikleri üzerine bir ölçek geliştirme çalışması. *Adnan Menderes Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 5* (2), 191-203. https://doi.org/10.30803/adusobed.387109

Oğuz Ünver, A., Arabacıoğlu, S., Okulu, H.Z (2015). Öğretmenlerin Bu Benim Eserim Proje Yarışması Rehberlik Sürecine İlişkin Görüşleri. *MSKU Eğitim Fakültesi Dergisi, 2*, 12-35.

Önen, F., Mertoğlu, H., Saka, M. & Gürdal, A. (2010). Hizmet içi eğitimin öğretmenlerin proje ve proje tabanlı öğrenmeye ilişkin bilgilerine ve proje yapma yeterliklerine etkisi: ÖPYEP örneği. *Ahi Evran Üniversitesi Eğitim Fakültesi Dergisi 11*(1), 137-158.

Özel, M. ve Akyol, C. (2016). Bu benim eserim projeleri hazırlamada karşılaşılan sorunlar, nedenleri ve çözüm önerileri. *GEFAD / GUJGEF, 36*(1), 141-173.

Tortop, H.S. (2014). Examining the Effectiveness of the In-service Training Program for the Education of the Academically Gifted in Turkey: A Case *Study. Journal for the Education of the Young Scientist and Giftedness, 2* (2), 67-86.

Tunca, N., Alkın, S., Aydın, Ö. (2015). Öğretmen Adaylarının Yaşam Boyu Öğrenme Eğilimleri. *Mersin University Journal of the Faculty of Education 11*, 2.

Wurdinger, S., Haar, J., Hugg, R., ve Bezon, J. (2007). A qualitative study using projectbased learning in a mainstream middle school. *Improving Schools, 10*, 150-161.

Yalın, H.İ. (2017). *Öğretim Teknolojileri ve Materyal Geliştirme", Öğretim Teknolojileri ve Materyal Geliştirme*, 29. Baskı (Ankara: Pegem Akademi, 12-16.

Yaşar, E. & Oral, B. (2024). Öğretmenlerin proje danışmanlık yeterlik düzeyleri: Ölçek geliştirme çalışması. *Türk Eğitim Bilimleri Dergisi, 22* (1), 464-486

Yıldız, Fidan, N., Mutlu, F. (2018). Fen bilimleri ve sınıf öğretmenlerinin proje tabanlı öğretim uygulamalarına ilişkin öz yeterliliklerinin incelenmesi. *Mehmet Akif Ersoy Üniversitesi Eğitim Fakültesi Dergisi 46*, 41-73

Sample texts regarding the presentations of the participants during the project are given below.

Team A: Study Area and Sampling

Using the YSI 85 Handheld Oxygen, Conductivity, Salinity, mg/L C and Temperature System measuring device, samples were collected on January 16, 2022, April 16, 2022, July 16, 2022, and November 16, 2022 from the location with coordinates 36.769917,34.561375 on the Viranşehir coast of Mersin. The temperature and salinity of the water were measured and recorded. Using the Karaman-Chappius process, it was extracted from the sand. Twenty samples were filtered using 50 µm filters from the trenches that were opened at a depth of one meter on the seashore. The samples that were gathered using the filters were sent to the Mersin University Chemistry Laboratory in jars that contained 96% ethanol..

Preparation: Using pipettes, samples in ethanol were put in a petri plate. Using the broken slide approach, copepod samples that were isolated by examination with an Olympus Trinocular Zoom Stereo Microscope (SZ61 TR) were prepared by placing them on a slide with glycerin drops. Prior to being examined under a ZEISS LSM 700 brand confocal microscope, the samples were separated and stained using a solution made with 0.5 grams of Congo Red and 100 milliliters of water. The stained sample was then placed in glycerin that was dropped onto the slide's ring file divider to finish the preparation. (Kamanlı and others.).

Species Determination: Using a ZEISS LSM 700 brand confocal microscopy with an x40 objective and an Olympus: CX22 brand light microscope with an x20 objective, the prepared samples were inspected. A light microscope with an x20 objective was used for dissection, and drawings were created. Utilizing the Turkey Ectinosomatidae Genus and Species Identification Key, the samples were identified by species. Karaytuğ, Süphan, and colleagues (2010).

CHAPTER 12

THE EFFECT OF DOCUMENTARIES ON CLIMATE CHANGE AWARENESS OF 5TH GRADE MIDDLE SCHOOL STUDENTS

Gamze SİPER KABADAYI [1]
Duygu SÖNMEZ [2]

INTRODUCTION

Documentaries, defined as "a film, radio or television program that gives facts about something," have the potential to significantly enhance the educational process due to their visual language and narrative content. In science and biology education they present valuable resources. Documentaries, as a storytelling medium, able to uniquely present real-world environmental issues with real people and events, rather than professional actors (Shapiro, 1997). Documentaries, have an immersive nature as they combine visual, auditory and narrative elements, which enables them to influence a broad range of audience on environmental issues including students (Bahk, 2010). In science education visualization of the abstract phenomena plays a critical role in the learning process and documentaries offer an effective alternative to hands-on experiences that are often limited by practical constraints of an average classroom (Öngel-Erdal, Sönmez, & Day, 2002).

The climate crisis, remains one of the most urgent global challenges demanding immediate action and awareness. The pandemic has brought out the interconnected nature of our globalized world, revealing how individual behaviors can influence broader systems. Global efforts to address the climate change focus on various sectors, such as industry and economy, with education receiving significant attention as a critical front in these initiatives. Development of curricula targeting content on or related to climate issues and environment is one of the ways we fight climate crisis. An understanding of the environment, climate related is-

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To reflect this interdisciplinary reality, school curricula should be structured to incorporate climate change education across multiple subjects, fostering broader awareness and understanding. By embedding climate change content into diverse disciplines, students not only gain comprehensive knowledge but also develop critical interdisciplinary process skills necessary for tackling complex, real-world problems of the twenty-first century (McCright et al., 2013). This approach offers a unique opportunity to prepare students as informed and proactive global citizens capable of addressing the challenges of climate change through collaborative and innovative solutions.

Students also cited printed sources, media channels, and their daily observations as key sources of information on climate change. This highlights an opportunity for future studies to design content aimed at increasing climate change awareness through the media platforms students frequently engage with, effectively capturing their attention.

The findings from the activity sheets revealed that while students felt sadness about climate change, they also expressed hope and a sense of responsibility to address the issue. However, the current study has some limitations, including a small sample size, the use of only one documentary in only one unit, and a focus on short-term effects without long-term follow-up. These factors may restrict the generalizability of the results.

Future research could explore the long-term impact of documentaries on student behavior and attitudes toward climate change. Additionally, studies incorporating multiple documentaries across various subjects could provide deeper insights into their effects on climate literacy. Examining emotional and behavioral changes in larger, more diverse student groups would further enhance understanding of the role of documentaries in fostering climate awareness and action.

REFERENCES

Ayvacı, H. S., & Özbek, D. (2019). The Effect of Documentary Films on Preservice Science Teachers' Views of Nature of Science. *Journal of Science Learning*, *2(3),* 97-107.

Bahk, C. M. (2010). Environmental education through narrative films: ımpact of medicine man on attitudes toward forest preservation. *The Journal of Environmental Education, 42(1)*, 1-13.

Barak, B., & Gönençgil, B. (2020). Dünyada ve Türkiye'de ortaokul öğretim programlarının iklim değişikliği eğitimi yaklaşımına göre karşılaştırılması. Coğrafya Dergisi, (40), 187-201.

Dal, B., Alper, U., Özdem-Yilmaz, Y., Öztürk, N., & Sönmez, D. (2015). A model for pre-service teachers' climate change awareness and willingness to act for pro-climate change friendly behavior: adaptation of awareness to climate change questionnaire. International *Research in Geographical and Environmental Education, 24(3),* 184–200. https://doi.org/10.1080/10382046.2015.1034456

Eisenack, K. (2013). A climate change board game for interdisciplinary communication and education. *Simulation & Gaming, 44(2-3)*, 328-348.

Fadzila, H. M., & Abd Raufb, R. A. (2019). Learning environmental issues through documentaries: exploring the perceptions of university students. *Learning, 7(6).*

Gök, A. (2012). İlköğretim Öğrencilerinin Çevre Bilgisi ve Çevresel Tutumları Üzerine Alan Araştırması (Doctoral dissertation, Necmettin Erbakan University (Turkey)).

Halady, I. R., & Rao, P. H. (2010). Does awareness to climate change lead to behavioral change? *International Journal of Climate Change Strategies and Management.*

Hosťovecký, M., & Štubňa, J. (2015). The Impact of Film-Based Learning in Science Education. In *New Trends in Networking, Computing, E-Learning, Systems Sciences, And Engineering* (Pp. 531-536). Springer, Cham.

Işıldar, G. Y. (2008). Meslek yüksekokulları boyutunda "çevre eğitimi" nin çevreci yaklaşımlar ve davranışlar üzerindeki etkilerinin değerlendirilmesi. *Türk Eğitim Bilimleri Dergisi*, 6(4), 759-778.

Karasar, N. (1991). Bilimsel araştırma teknikleri (4th ed.).

Liu, S. C. (2018). Environmental education through documentaries: assessing learning outcomes of a general environmental studies course. *Eurasia Journal of Mathematics, Science and Technology Education,* 14(4), 1371-1381.

McCright, A. M., O'shea, B. W., Sweeder, R. D., Urquhart, G. R., & Zeleke, A. (2013). Promoting interdisciplinarity through climate change education. *Nature Climate Change, 3(8),* 713-716.

MEB. (2024) Fen Bilimleri Dersi Taslak Öğretim Programı İlkokul ve Ortaokul 3, 4, 5, 6, 7, 8. sınıflar). Ankara: Temel Eğitim Genel Müdürlüğü.

Öngel-Erdal, S., Sonmez, D., & Day, R. (2004). Science fiction movies as a tool for revealing students› knowledge and alternative conceptions. Online Submission.

Shapiro, A. L. (1997). How Real Is the Reality in Documentary Film? Jill Godmilow, in conversation with Ann-Louise Shapiro. *History and Theory, 36(4), 80-101.*

Şeker, S. (2018). İlköğretim 7-8. Sınıf Öğrencilerinin Sürdürülebilir Kalkınma ve İklim Değişikliğine Yönelik Tutum ve Davranışları (Doctoral dissertation, Necmettin Erbakan University (Turkey)).

USGCRP (US Global Change Research Program). 2009. Climate Literacy: The Essential Principles of Climate Science. Washington, DC: NOAA Climate Program Office.

CHAPTER 13

THE EUROPEAN GREEN DEAL: ROADMAP FOR SUSTAINABLE GROWTH AND CLIMATE NEUTRALITY

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INTRODUCTION

The European Green Deal is a novel growth strategy designed to convert the EU into a just and thriving society characterized by a modern, resource-efficient, and competitive economy that achieves net-zero greenhouse gas emissions by 2050 while decoupling economic growth from the consumption of resources. The European Commission publishes it on 11 December 2019 (European Commission, 2019). Advances in transport, agriculture systems ecosystems, and biodiversity are all required, as well as efforts to further develop a circular economy that ensures products can be reused and recycled. From 2021 to 2027, 35 percent of the EU's research funding will be dedicated to developing climate-friendly technologies. The European Green Deal represents a collective effort by the EU to address the pressing challenges posed by climate change and environmental degradation while fostering economic growth and social well-being within a sustainable framework. It involves legislation, funding mechanisms, and collaborations between member states, industries, and civil society to achieve its ambitious goals. Key objectives of the European Green Deal include (Figure 1):

- Climate Neutrality: The primary goal is to make Europe the world's first climate-neutral continent by 2050. This entails reducing greenhouse gas emissions to net-zero levels, where any remaining emissions are offset by measures such as carbon capture or reforestation.
- Clean Energy: The deal emphasizes adopting renewable and clean energy sources, reducing reliance on fossil fuels, and promoting energy efficiency to achieve a sustainable energy system.

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of electric vehicle production facilities, further solidify Turkey's role in the regional green transformation. Despite these efforts, significant challenges remain. Agriculture, energy, and waste management sectors require substantial reforms to meet EU sustainability criteria. The potential impacts of the Carbon Border Adjustment Mechanism (CBAM) demand accelerated decarbonization and resource efficiency improvements. Strengthening public-private collaboration, leveraging international partnerships, and mobilizing financial resources will be critical for Turkey to overcome these hurdles and fully integrate into the European Green Deal's framework.

On a global scale, the European Green Deal serves as a benchmark for sustainability, showcasing how policy integration, technological innovation, and international cooperation can converge to address complex environmental challenges. Including biodiversity strategies, nature-based solutions, and zero-pollution ambitions reinforces the need for a balanced approach that aligns economic growth with ecological preservation.

In conclusion, the European Green Deal exemplifies a visionary and inclusive strategy for achieving climate neutrality and sustainable development. Its implementation requires a coordinated effort across all sectors and stakeholders, not only within the EU but also in collaboration with neighboring regions and global partners. For countries like Turkey, aligning with the EGD allows them to modernize their economies, enhance competitiveness, and contribute meaningfully to global environmental objectives. As the EU and its partners advance towards these shared goals, the European Green Deal emerges as a transformative blueprint, offering lessons and inspiration for a sustainable and equitable future worldwide.

REFERENCES

August, H. (2023). Achieving a just transition towards environmentally sustainable economies and societies for all.

Brenton, P., & Chemutai, V. (2021). The trade and climate change nexus: the urgency and opportunities for developing countries. World Bank Publications.

Directorate for EU Affairs. (2024). Chapter 27- Environment and Climate Change. Environmental And Climate Change Policy Of The Eu.

Elegbede, I. O., Akintola, S. L., Jimoh, A. A. A., Jolaosho, T. L., Smith-Godfrey, S., Oliveira, A., ... & Oloko, A. (2023). Blue economy (sustainability). In Encyclopedia of Sustainable Management (pp. 1-9). Cham: Springer International Publishing.

ESCAP, U. (2020). Connecting transport infrastructure networks in Asia and Europe to support interregional sustainable transport connectivity: progress in enhancing transport connectivity between Asia and Europe.

European Association for Storage of Energy. (2019). Long-Term Strategy for 2050 - A Clean Planet for All.

European Commission. (2018). A Clean Planet for All: A European strategic long-term Vision for a Prosperous, modern, competitive, and climate-neutral economy. Brussels

European Commission. (2019). Communication from the Commission, "The European Green Deal". Brussels 11-12-2019, link: EUR-Lex-52019DC0640-EN-EUR-Lex (Europa. eu).

European Commission. (2020). Communication From The Commission To The European Parliament, The Council, The European Economic And Social Committee And The Committee Of The Regions. Brussels.

European Commission. (n.d.). Energy and the Green Deal.

European Parliament. (2022). Green Deal: Key to a Climate-Neutral and Sustainable EU.

Giannelli, E. and Fischer L. (2020). Energy Infrastructure For A European Green Deal Benchmarks For The New Transeuropean Networks For Energy Regulation (Ten-E).

Hassan, Q., Viktor, P., Al-Musawi, T. J., Ali, B. M., Algburi, S., Alzoubi, H. M., ... & Jaszczur, M. (2024). Renewable energy's role in global energy Transformations. Renewable Energy Focus, 48, 100545.

Kreienkamp, J. The United Nations Sustainable Development Goals on Biodiversity, Climate Change and Health.

Neligan, A., Schleicher, C., Engels, B., & Kroke, T. (2023). Relevance and practicability for companies.

Nicol, S., & Park, A. (Eds.). (2021). Green Budget Tagging: Introductory Guidance & Principles. OECD.

Perdana, S., & Vielle, M. (2022). Making the EU Carbon Border Adjustment Mechanism acceptable and climate-friendly for least-developed countries. Energy Policy, 170, 113245.

Schebesta, H., & Candel, J. J. (2020). The game-changing potential of the EU's Farm to Fork Strategy. Nature Food, 1(10), 586-588.

UNEP, F. (2024). Climate Risks in the Transportation Sector.

CHAPTER 14

THE LEVEL OF ABILITY OF 8TH SCIENCE AND TECHNOLOGY SYLLABUS TO RAISE INTEREST OF STUDENTS TOWARDS BIOTECHNOLOGY

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INTRODUCTION

In the last quarter of the twentieth century, the greatest development in biology has occurred in the field of biotechnology. In particular, the discovery of endonucleases that recognize specific sequences of the DNA molecule and make intelligent cuts has opened the way to manipulate the genetic information of one species and combine it with the genetic information of another species. This situation brings an opening before humanity, where it is not known where it will end. It is now possible to use the genetic information of the living organism by directing its existing power in the production of goods and services. This development, which expresses the transformation of biological information into technology, has taken its place in the scientific literature as 'Biotechnology' and 'Genetic Engineering'. This represents such an important development that there have even been those who have called our age the 'Century of Biology' (Kaytancı, 2004; Beizer & Case,1990).

If we want our students to be good consumers and decision makers in the future, they need to be provided with sufficient knowledge. Having sufficient knowledge will enable students to develop positive attitudes towards science and technology (Hilton et al., 2011). With a good biotechnology education, students can be given the opportunity to form their own opinions about the risks and disadvantages of modern biotechnology, as well as up-to-date and accurate information (Chen & Raffan, 1999; Şahin & Ünaldı Coral, 2023).

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in education, and techniques that prioritize concretizing elements and visual elements such as videos, slides, computers and the internet should be included.

- The learning levels of genetic engineering and biotechnology concepts should be determined, concepts that are difficult to learn should be determined and new strategies should be developed for teaching these concepts.
- Science and technology teachers should be trained as knowledgeable and experienced in the fields of genetic engineering and biotechnology so that they can convey correctly; In order for them to keep up with the rapidly developing technology in today's conditions and to update their knowledge, in-service training should be given and opportunities should be prepared in line with these purposes.

REFERENCES

Atasoy, B., Atıcı, T., Taşar, M. F., & Taflı, T. (2020) Development and Validation of Biotechnology Knowledge Scale (BKS). Hellenic Journal of STEM Education, 1(1), 33–42. https://doi.org/10.51724/hjstemed.v1i1.3.

Bahri, N. M., Suryawati, E., & Osman, K. (2014) Students' Biotechnology Literacy: The Pillars of STEM Education in Malaysia. *Eurasia Journal of Mathematics, Science and Technology Education, 10*(3), 195-207. https://doi.org/10.12973/eurasia.2014.1075a

Beizer, B. & Case, C. L. (1990) What is Biotechnology? *The American Biology Teacher, 52*(6), 376-378.

Cavanagh, H., Hood, J. & Wilkinson, J. (2005) Riverina high school students' views of biotechnology. *Issues in Biotechnology Teaching,* 8 (2).

Chen, S. Y. & Raffan, J. (1999) Biotechnology: Student's knowledge and attitudes in the UK and Taiwan. *Journal of Biological Education,* 34 (1), 17–23.

Dawson, V. & Soames, C. (2006) The effect of biotechnology education on Australian high school students' understandings and attitudes about biotechnology processes. *Research in Science And Technological Education,* 24 (2), 183–198.

Dawson, V. (2007) An exploration of high school (12–17-year-old) students' understandings of and attitudes towards biotechnology processes. *Research in Science Education,* 37, 59–73.

Demirci, M., & Yüce, Z. (2018) Experimental planning of the lesson for 8th grade students in teaching the subject of biotechnology and genetic engineering. *Sakarya Üniversitesi Eğitim Fakültesi Dergisi,* 35, 87108.

Eroğlu, S. (2006). *Görsel ve işitsel materyal kullanımının ortaöğretim 3. sınıf öğrencilerinin biyoteknoloji ile ilgili kavramları öğrenmeleri ve tutumları üzerine etkisi.* Yüksek Lisans Tezi, Gazi Üniversitesi Eğitim Bilimleri Enstitüsü, Ankara.

Garrett, S. (2009). *Professional development for the integration of biotechnology education.* Unpublished Maters of Education thesis. Queensland University of Technology.

Hilton, A., Nichols, K. and Kanasa, H. (2011) Developing tomorrow's decision-makers: *Opportunities for biotechnology education research.* Australian Educational Researcher, 38 4: 449-465.

Karasar, N. (1984). *Bilimsel araştırma yöntemleri.* Ankara: Hacettepe Taş.

Kaytancı, T. E. (2004). *Ortaöğretim öğrencilerinin genetik mühendisliğine ilgilerinin belirlenmesi.* Yüksek Lisans Tezi, Gazi Üniversitesi Eğitim Bilimleri Enstitüsü, Ankara.

Kidman, G. (2009) What is an 'ınteresting curriculum' for biotechnology education? students and teachers opposing views. *Research in Science Education,* http://dx.doi.org/10.1007/s11165-009-9125-1

Klop, T. & Severiens, S. (2007) An exploration of attitudes towards modern biotechnology: A study among Dutch secondary school students. *International Journal of Science Education,* 29 (5), 663–679.

Leslie, G. & Schibeci, R. (2003) What do science teachers think biotechnology is? Does it matter? *Australian Science Teachers Journal*, 49 (3), 16-21

N Umamah, K Mahmudi, Agustiningsih, & Suratno. (2020). Development of Augmented Reality in Biotechnology processes as a Supporting Media for Science Learning Modules in Elementary Schools. *IOP Conference Series: Earth and Environmental Science*, 485: 012069. https://doi.org/10.1088/1755-1315/485/1/012069

Severcan, F. Ozan, A., & Haris, P. I. (2000) Development of biotechnology education in Turkey. *Biochemical Education,* 28 (1), 36-38. https://doi.org/10.1016/S0307-4412(99)00116-8

Sinan, O. (2015). Öğrencilerin Biyoteknoloji İle İlgili Bilgi ve Tutumların Farklı Değişkenlere Göre İncelenmesi (Investigation of Students' Knowledge and Attitudes about Biotechnology According to Different Variables). *YYÜ Eğitim Fakültesi Dergisi,* 12 (1), 183-201.

Soetaert W. & Vandamme, E. (2006) Endüstriyel Biyoteknolojinin Etkisi (The impact of industrial biotechnology). *Biotechnology Journal,* 1, 756–769.

Şahin, B., & Ünaldı Coral, M. N. (2023) Fen Bilimleri Öğretmenlerinin Biyoteknoloji Öğretimi Konusundaki Görüşlerinin İncelenmesi. *Fen Bilimleri Öğretimi Dergisi*, 11 (2), 327-355. https://doi.org/10.56423/fbod.1265205

Thieman, J. W. & Palladino, A. M. (2013). *Biyoteknolojiye giriş (Introduction to biotechnology)* (Translated by M. Tekeoğlu,). Ankara: Palme Yayıncılık

Üstün, Ç., & Demirci, N. (2106) Biyoteknoloji, tıp ve etik (Biotechnology, medicine and ethics). *Ege Tıp Dergisi / Ege Journal of Medicine,* 55 (3), 158-162.

Zhou, X., Lin, J., Zhang, L., Chen, Z., Yin, Y., Guo, B., Sun, X. & Tang, K. (2006). The development of biotechnology education in China. *Biochemistry and Molecular Biology Education,* 34 (2), 141-147.

CHAPTER 15

THE ROLE OF EXPERIENTIAL LEARNING IN DEVELOPING STUDENTS' ATTITUDES TOWARDS SUSTAINABILITY IN TOURISM EDUCATION

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INTRODUCTION

Good planning of the facilities ensures that students are successful and motivated in lessons. Educational institutions are constantly looking for new ways in this direction. Their goal is to excite and motivate students (Al Rawashdeh et al., 2021). Providing the right environment and using innovative products are very important to ensure that the lesson is permanent in the minds of the students. Technology plays an important role in studies to ensure that students are active in the lesson. While technology makes the lessons fun and simple, it also facilitates access to information (Raja & Nagasubramani, 2018).

Many fields of education are carrying out research on technological tools that can be used during the planning of lessons and teaching activities. The acquisition of appropriate materials according to the needs and possibilities leads to significant changes in the way lessons are taught. This affects students' desire to learn and the success of the school (Kaur, et al., 2020).

Tourism education will facilitate the paradigm shift from passive to transformative. Therefore, the role of tourism education in driving the transformative agenda needs to be reorganised. There are various approaches to tourism education that focus on vocational training.

These are a balanced approach, a work-centred approach, a student-centred approach and a community-centred approach. A balance between theory and

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REFERENCES

Abduvakhabova, U. Y. (2020). Education in Tourism Industry: Challenges and Opportunities. *Indonesian Journal of Law and Economics Review*, *6*, 10-21070.

Al Rawashdeh, A. Z., Mohammed, E. Y., Al Arab, A. R., Alara, M., & Al-Rawashdeh, B. (2021). Advantages and disadvantages of using e-learning in university education: Analyzing students' perspectives. *Electronic Journal of E-learning*, *19*(3), 107-117.

Andresen, L., Boud, D., & Cohen, R. (2020). Experience-based learning. In *Understanding adult education and training* (pp. 225-239). Routledge.

Başaran, K. (2016). Experiential learning in tourism education in the North Cyprus. (Master Thesis). School of Education, Unıversıty Of Tampere.

Betak, N. (2020). The use of active learning approach in tourism education: Pilot study of student's attitude. In *International Academic Institute Book of Proceedings International Academic Conference* (pp. 52-60).

Bilsland, C., Nagy, H., & Smith, P. (2020). Virtual Internships and Work-Integrated Learning in Hospitality and Tourism in a Post-COVID-19 World. *International Journal of Work-Integrated Learning*, *21*(4), 425-437.

Bowan, D., & Dallam, G. (2020). Building bridges: overview of an international sustainable tourism education model. *Journal of Teaching in Travel & Tourism*, *20*(3), 202-215.

Camargo, B. A., & Gretzel, U. (2017). What do tourism students know about sustainability and sustainable tourism? An exploratory study of Latin American students. *Journal of Teaching in Travel & Tourism*, *17*(2), 101-117.

Chau, S., & Cheung, C. (2018). Academic satisfaction with hospitality and tourism education in Macao: The influence of active learning, academic motivation, and student engagement. *Asia Pacific Journal of Education*, *38*(4), 473-487.

Chen, M., Pei, T., Jeronen, E., Wang, Z., & Xu, L. (2022). Teaching and learning methods for promoting sustainability in tourism education. *Sustainability*, *14*(21), 14592.

Darmiany, D., Widiada, I. K., Nisa, K., Maulyda, M. A., & Nurmawanti, I. (2021). Strengthening character value based on experiential learning to reduce student academic cheating behavior. *Premiere Educandum: Jurnal Pendidikan Dasar dan Pembelajaran*, *11*(1), 135.

Dung, D. T. H. (2020). The advantages and disadvantages of virtual learning. *IOSR Journal of Research & Method in Education*, *10*(3), 45-48.

Edelheim, J. (2020). How should tourism education values be transformed after 2020?. *Tourism Geographies*, *22*(3), 547-554.

Elshaer, A. M., & Marzouk, A. M. (2019). *Labor in the tourism and hospitality industry: Skills, ethics, issues, and rights*. Apple Academic Press.

Gössling, S. (2018). Tourism, tourist learning and sustainability: An exploratory discussion of complexities, problems and opportunities. *Journal of Sustainable Tourism*, *26*(2), 292-306.

Green, A. J., & Sammons, G. E. (2014). Student learning styles: Assessing active learning in the hospitality learners model. *Journal of Hospitality & Tourism Education*, *26*(1), 29-38.

Harden, S. M., Allen, K. C., Chau, C. N., Parks, S. L., and Zanko, A. L. (2012). Experiential learning in graduate education: Development, delivery, and analysis of an evidence-based intervention. Creative Education, 3, 649–657.

Healey, M., and Jenkins, A. (2000). Kolb's experimental learning theory and its application in geography in higher education. Journal of Geography, 99(5),185-195.

Kaur, D. P., Mantri, A., & Horan, B. (2020). Enhancing student motivation with use of augmented reality for interactive learning in engineering education. *Procedia Computer Science*, *172*, 881-885.

Khan, N., Hassan, A. U., Fahad, S., & Naushad, M. (2020). Factors affecting tourism industry and its impacts on global economy of the world. *Available at SSRN 3559353*.

Kihm, H. S., & Slawson, J. (2020). Performance-based learning: A case study in experiential education. *Journal of Family & Consumer Sciences*, *112*(2), 65-71.

Kim, A. K., & Davies, J. (2014). A teacher's perspective on student centred learning: Towards the development of best practice in an undergraduate tourism course. *Journal of Hospitality, Leisure, Sport & Tourism Education*, *14*, 6-14.

Kolb, A. Y., and Kolb, D. A. (2017). The experiential educator: Principles and practices of experiential learning. EBLS Press, Kaunakakai, HI.

Kong, Y. (2021). The role of experiential learning on students' motivation and classroom engagement. *Frontiers in Psychology*, *12*, 771272.

Malihah, E., & Setiyorini, H. P. D. (2014, October). Tourism education and edu-tourism development: Sustainable tourism development perspective in education. In *The 1st International Seminar on Tourism (ISOT)-"Eco-Resort and Destination Sustainability: Planning, Impact, and Development* (pp. 1-7).

McKercher, B., Prideaux, B., & Pang, S. F. (2013). Attitudes of tourism students to the environment and climate change. *Asia Pacific Journal of Tourism Research*, *18*(1-2), 108-143.

Mínguez, C., Martínez-Hernández, C., & Yubero, C. (2021). Higher education and the sustainable tourism pedagogy: Are tourism students ready to lead change in the post pandemic era?. *Journal of Hospitality, Leisure, Sport & Tourism Education*, *29*, 100329.

Morris, T. H. (2020). Experiential learning–a systematic review and revision of Kolb's model. *Interactive learning environments*, *28*(8), 1064-1077.

Raja, R., & Nagasubramani, P. C. (2018). Impact of modern technology in education. *Journal of Applied and Advanced Research*, *3*(1), 33-35.

Sheldon, P. J., Fesenmaier, D. R., & Tribe, J. (2016). The tourism education futures initiative (TEFI): Activating change in tourism education. In *The tourism education futures initiative* (pp. 14-35). Routledge.

Silvestri, C., Aquilani, B., & Ruggieri, A. (2017). Service quality and customer satisfaction in thermal tourism. *The TQM Journal*, *29*(1), 55-81.

Slocum, S. L., Dimitrov, D. Y., & Webb, K. (2019). The impact of neoliberalism on higher education tourism programs: Meeting the 2030 sustainable development goals with the next generation. *Tourism Management Perspectives*, *30*, 33-42.

Sokhanvar, Z., Salehi, K., & Sokhanvar, F. (2021). Advantages of authentic assessment for improving the learning experience and employability skills of higher education students: A systematic literature review. *Studies in Educational Evaluation*, *70*, 101030.

Şahin, Ç. Ç. (2022). Öğretmenlerin deneyimsel öğrenme ile ilgili görüşlerinin incelenmesi. *Çağdaş Yönetim Bilimleri Dergisi*, *9*(2), 60-71.

Tiwari, P., Séraphin, H., & Chowdhary, N. R. (2021). Impacts of COVID-19 on tourism education: Analysis and perspectives. *Journal of Teaching in Travel & Tourism*, *21*(4), 313-338.

Tokhirovich, T. K. (2021). The Role and Importance of Tourism in the Economy of Small Regions. *International Journal of Culture and Modernity*, *9*, 62-66.

Tomasi, S., Paviotti, G., & Cavicchi, A. (2020). Educational tourism and local development: The role of universities. *Sustainability*, *12*(17), 6766.

Voukelatou, G. (2019). The contribution of experiential learning to the development of cognitive and social skills in secondary education: A case study. Education Sciences, 9(2), 127–138.

Wu, H. C., Chen, X., & Chang, Y. Y. (2021). What drives green experiential outcomes in tourism higher education?. *Journal of Hospitality, Leisure, Sport & Tourism Education*, *29*, 100294.

Zagonari, F. (2009). Balancing tourism education and training. *International Journal of Hospitality Management*, *28*(1), 2-9.

Zhang, S. (2019). From greenway to sustainable tourism: experiential learning. (Master Thesis). School of Hotel and Tourism Management, Hong Kong Polytechnic University.

Zhu, K., Zhou, Q., Cheng, Y., Zhang, Y., Li, T., Yan, X., ... & Dávid, L. D. (2023). Regional sustainability: Pressures and responses of tourism economy and ecological environment in the Yangtze River basin, China. *Frontiers in Ecology and Evolution*, *11*, 1148868.

CHAPTER 16

THE USE OF AUGMENTED REALITY IN THE TEACHING OF THE WATER CYCLE[1]

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INTRODUCTION

Various research studies have been conducted, and applications have been developed on how to use technological developments in education. In recent years, one of these developments, augmented reality technology, has been widely used to make it easier to understand subjects that are difficult to visualize and increase students' interest in the subject. Augmented reality is a technology that integrates the features of real-world events with the virtual environment and enriches abstract concepts with concrete images (Azuma, 1997). Studies investigating the effects of augmented reality applications on cognitive and affective domains in teaching different biology topics, such as the classification of living things, systems, energy transformations, and cell divisions, have been conducted, and it has been determined that they make positive contributions (Erbaş & Demirer 2019; Altınışık, 2021; Karadavut, 2021; Çiloğlu, 2022). Among biology subjects, the water cycle is essential in terms of environmental education and protection of ecological balance (Çelikler & Topal, 2011). Within the scope of the ecology course, it has been determined that students lack knowledge and have some misconceptions about the water cycle, which has a significant place in the world (Derman & Yaran, 2017; Koomson & Owusu-Fordjour, 2018). While teaching ecology

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given an opportunity to develop applications. Future studies can be conducted to examine the effectiveness of augmented reality applications in teaching different biology subjects.

REFERENCES

Abdüsselam, M. S. (2016). Fizik öğretiminde artırılmış gerçeklik ortamlarının kullanımlarına ilişkin öğretmen ve öğrenci görüşleri: 11. sınıf manyetizma konusu örneği. *Pegem Eğitim ve Öğretim Dergisi, 4* (1), 59-74.

Altınışık, D. (2021). Canlılarda enerji dönüşümleri ünitesine yönelik artırılmış gerçeklik uygulamalarının geliştirilmesi, uygulanması ve değerlendirilmesi. [Yayımlanmamış doktora tezi], Trabzon Üniversitesi.

Azuma, R. (1997). A Survey of augmented reality. *Presence: Teleoperators and Virtual Environments, 6*, 355-385. Doi: 10.1162/pres.1997.6.4.355.

Çankaya, B., & Girgin, S. (2018). Artırılmış gerçeklik teknolojisinin fen bilimleri dersi akademik başarısına etkisi. *Uluslararası Beşeri ve Sosyal Bilimler İnceleme Dergisi* , *5* (30), 4283-4290.

Çelikler, D., & Topal, N. (2011). İlköğretim fen bilgisi öğretmen adaylarının karbondioksit ve su döngüsü konusundaki bilgilerinin çizim ile saptanması. *Dünya Eğitim ve Öğretim Çalışmaları Dergisi, 1* (1), 7-79.

Çiloğlu, T. (2022). Artırılmış gerçeklik temelli öğrenme ortamı: artırılmış gerçekliğin lise öğrencilerinin biyoloji eğitiminde motivasyonu, tutumu ve öz yeterliği üzerindeki etkileri. [Yayımlanmamış yüksek lisans tezi], Bartın Üniversitesi.

Derman, A., & Yaran, M. (2017). Lise Öğrencilerinin Su Döngüsü Konusuyla İlgili Bilgi Yapıları. *Mustafa Kemal Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 14* (39), 255-274.

Erbas C., & Demirer V. (2019). The effects of augmented reality on students' academic achievement and motivation in a biology course. *Journal of Comput Assist Learning, 35*, 450-458. Doi:10.1111/jcal.12350

Karadavut, Z. (2021). Artırılmış gerçeklik uygulamalarının 11.sınıf lise öğrencilerinin dolaşım sistemi konusundaki akademik başarılarına etkisi. [Yayımlanmamış yüksek lisans tezi], Gazi Üniversitesi.

Kırıkkaya, E. B., & Şentürk, M. (2018). Güneş Sistemi ve Ötesi Ünitesinde Artırılmış Gerçeklik Teknolojisi Kullanılmasının Öğrenci Akademik Başarısına Etkisi. *Kastamonu Eğitim Dergisi*, *26* (1), 181-189.

Koomson, C. K., & Owusu-Fordjour, C. (2018). Misconceptions of senior high school science students on evaporation and water cycle. *European Journal of Research and Reflection in Educational Sciences Vol*, *6* (5), 13-28.

Özocak, T. (2022). Artırılmış gerçeklik teknolojisinin 7. sınıf hücre ve bölünmeleri ünitesinde öğrencilerin akademik başarılarına, kalıcılık düzeylerine, artırılmış gerçeklik teknolojisine karşı tutumları ve bilişim teknolojilerinden yararlanma düzeylerine etkisi. [Yayımlanmamış yüksek lisans tezi], Trakya Üniversitesi.

Yalçın Çelik, A. (2019). Biyoloji ve Kimya Öğretmen Adaylarının Artırılmış Gerçeklik Materyalleri Deneyimi. *Karaelmas Eğitim Bilimleri Dergisi, 7* (1), 123-132.