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Original article

Development of an Educational Computer Game for Orienteering

Osman Demirhan [a] & Ebru Yılmaz İnce [b, *]

[a] Department of Computer Engineering, Faculty of Technology, Isparta University of Applied Science, Isparta, Türkiye
[b] Department of Computer Sciences, Isparta University of Applied Science, Isparta, Türkiye

Abstract

Orienteering is a sport that combines physical movement with cognitive skills such as map reading, compass navigation, and route planning. However, due to various environmental and physical constraints, not everyone has access to this sport. With the rise of digital technologies, interactive and educational mobile games offer a new opportunity to bring such experiences to wider audiences. Thanks to immersive design elements such as sound effects, intuitive controls, and three-dimensional virtual environments, today's educational games attract significant attention and provide learners with engaging learning environments. In this study, an educational mobile game that simulates orienteering tasks was developed using the Unity game engine and C# programming language. The game includes interactive missions, a story-driven structure, and dual-language support, and is playable entirely offline. It is believed that this orienteering-themed educational game will attract learners from various age groups and can be used to increase motivation, knowledge, and awareness about orienteering through digital learning environments.

Keywords: Orienteering, Educational Technology, Game-Based Learning, Computer Game, Map Navigation

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* **Corresponding author:**

Yılmaz İnce E. is an Assoc Prof., in Department of Computer Sciences, Isparta University of Applied Science, Isparta, Türkiye. Her research interests include gigital games, metaverse anf sofware. She has lived, worked, and studied in Isparta, Türkiye.
Email: ebruince@isparta.edu.tr

INTRODUCTION

The integration of technology into education has paved the way for innovative learning methodologies, with computer games emerging as a potent tool for engaging students and enhancing comprehension across diverse subjects (Ali et al., 2024; Eden et al, 2024). This approach is particularly relevant in domains that benefit from experiential learning and skill application (Kucher, 2021). The development of educational computer games presents a unique opportunity to create immersive and interactive environments that foster knowledge acquisition and cognitive development (Jantakun & Jantakoon, 2021).

Educational games, tailored for specific subjects, can offer a dynamic and engaging way for students to learn, moving away from traditional lecture-based methods (İnce, 2018). The creation of such games, however, is a multifaceted endeavor that necessitates expertise in various disciplines, including game design, software engineering, instructional design, and the subject matter itself (Aslan & Balcı, 2015). One such subject that could significantly benefit from the implementation of educational games is orienteering, a sport that combines navigation and physical endurance (Becker, 2005). Orienteering requires participants to navigate through unfamiliar terrain using a map and compass, demanding a unique blend of cognitive and physical skills (Reyes et al., 2021). An educational computer game focused on orienteering can offer a virtual environment for learners to develop and practice these skills in a safe, engaging, and accessible manner.

Literature Review

The integration of digital technologies into education has led to the development of interactive and immersive learning environments, particularly through digital game-based learning (DGBL). These tools not only engage students but also enhance cognitive and practical skill development in ways traditional methods often cannot (Prensky, 2007). Digital games, when designed with pedagogical intent, provide meaningful, task-oriented learning experiences that promote motivation, autonomy, and critical thinking (Gee, 2003; Nadeem et al., 2023; Plass et al., 2015). Furthermore, digital gameplay fosters critical thinking, adaptability, and sustained engagement, all of which contribute to deeper learning outcomes (Zakaria & Zakaria, 2024).

In recent years, research has focused increasingly on the effectiveness of educational games in promoting spatial, strategic, and decision-making skills. For instance, studies have demonstrated that well-structured game environments enhance problem-solving and engagement across domains such as geography and science (Qian & Clark, 2016; Mayer, 2019). Specifically, location-based games, such as those simulating orienteering tasks, have shown promise in improving spatial orientation and real-world navigation skills (Yiğit & Karatekin, 2021; Hermida-Arias & Martínez-Monés, 2025).

Orienteering as a sport involves real-time decision-making, spatial navigation, and physical coordination—all of which align closely with the affordances of interactive digital games. Implementing orienteering in a virtual environment allows learners to engage in simulated experiences that replicate real-world tasks without the physical or environmental limitations of outdoor activity (Reyes et al., 2021; Notarnicola et al., 2012).

Furthermore, mobile learning (m-learning) technologies have expanded access to educational content, enabling learning anytime and anywhere. Studies highlight that mobile-supported educational games increase learners' autonomy and adaptability while fostering motivation through interactivity and gamified challenges (Sharples et al., 2015; Alrasheedi et al., 2015). The Unity game engine, for instance, allows for the creation of dynamic 3D learning environments accessible via smartphones and tablets, supporting flexible and inclusive learning (Kucher, 2021).

Augmented reality (AR) and virtual reality (VR) technologies have further advanced game-based learning. Their integration into mobile orienteering games supports experiential learning, allowing students to immerse themselves in scenarios that combine digital and physical navigation (Liu, 2025; Cassidy & Gabbard, 2024). When combined with sound instructional design, these tools can significantly enhance retention and engagement (Ifenthaler et al., 2019; Huang et al., 2019).

The literature suggests that educational games—particularly those involving real-life simulation like orienteering—are powerful instruments for modern pedagogy. These tools not only make abstract concepts more tangible but also cultivate essential cognitive and navigational skills in learners of all ages. In this research, a three-dimensional educational game focusing on orienteering has been developed. Orienteering is a sport that combines physical activity with map reading and directional skills, encouraging spatial reasoning, rapid decision-making, and independent problem-solving. Despite its educational value, the sport's reliance on outdoor environments can pose accessibility challenges for some learners. To address this issue, the developed game simulates core orienteering tasks in a virtual setting, offering a story-driven, interactive format suitable for both formal and informal educational use. The game aims to teach fundamental orienteering skills, such as interpreting topographic maps, using a compass, and navigating unfamiliar terrain. By embedding these learning goals in a narrative context, the game enhances player motivation while maintaining educational rigor. Through this approach, learners are provided with a flexible and engaging platform that mirrors real-life problem-solving scenarios in a controlled, digital environment.

METHOD

In this study, the developmental research method, classified under Design-Based Research (DBR), was employed to guide the creation of an educational mobile game. DBR not only aims to develop innovative educational tools for authentic environments but also seeks to analyze their influence

on learning processes (Anderson & Shattuck, 2012). Developmental research involves both product development and the examination of its pedagogical effectiveness (McKenney & Reeves, 2018).

Within this framework, an orienteering-themed educational game was developed specifically for mobile platforms. Designing for mobile devices allows learners to access educational content regardless of time and location, thus promoting flexible and personalized learning (Alrasheedi et al., 2015). The increasing popularity of mobile learning among younger demographics supports the integration of educational games into everyday routines (Traxler, 2018). Accordingly, the game was developed using the Unity engine for Android systems and optimized for full touchscreen interaction.

The game is an educational digital experience designed to introduce elementary school students to the fundamental concepts of orienteering through interactive and age-appropriate gameplay. Orienteering is a sport and educational activity that combines navigation skills, map reading, spatial thinking, and decision-making, and the game adapts these elements into a virtual learning environment that is accessible and engaging for young learners. Within the game, players learn core orienteering skills such as understanding maps, recognizing symbols, using directional cues, and planning routes to reach specific checkpoints. These mechanics mirror real-world orienteering practices, allowing students to develop spatial awareness and problem-solving abilities in a structured and guided digital setting. By progressing through levels and completing navigation-based challenges, learners practice orienting themselves in space, interpreting visual information, and making strategic choices—key competencies associated with orienteering education.

The game also emphasizes experiential and game-based learning principles by encouraging exploration, trial and error, and active participation rather than passive instruction. Through immediate feedback and progressively challenging tasks, students gain confidence in navigation skills while maintaining high levels of motivation and engagement. As a result, the game serves as both an introduction to orienteering and a supportive learning tool that prepares students for real-world orienteering activities by strengthening their spatial thinking and navigational literacy in an enjoyable digital format.

The development process was carried out using Unity 3D, and all gameplay mechanics were programmed in C#. Key gameplay elements include spatial navigation, map-based puzzle solving, interactive missions, and timed challenges. These elements are designed to activate higher-order cognitive skills such as decision-making, critical thinking, and problem-solving (Mayer, 2019; Hamari et al., 2016).

The user interface (UI) was designed to be clean and accessible, with support for both Turkish and English to ensure broader user accessibility. As user interface design plays a crucial role in mobile

learning engagement, intuitive interaction was prioritized to enhance learner motivation and reduce cognitive load (Ting et al., 2020).

To ensure compatibility and performance, the game was tested on a mid-range Android smartphone with 4 GB RAM and an octa-core processor. This approach guarantees usability even on devices with modest technical specifications, thereby supporting equity in digital access.

RESULTS

In this section, the structure, progression, and key mechanics of the developed orienteering educational game are presented in detail. The game was designed to provide an interactive learning experience aligned with pedagogical models such as EFM (Effective learning environment, Flow, and Motivation). Each stage of the game was carefully designed to support player motivation, spatial awareness, and problem-solving abilities. The following subsections illustrate the core components of the game through descriptive narratives and visual examples, showing how learning objectives are embedded into the gameplay process. According to Gee (2003), well-designed educational games can embody learning theories by engaging learners through challenge, feedback, and contextual problem-solving.

When the game begins, players are introduced with an interactive information screen explaining the gameplay, controls, and objectives (Figure 1). After the introduction, the player enters a 3D forest environment and starts interacting with orienteering control flags placed at various locations on the map (Figure 2).

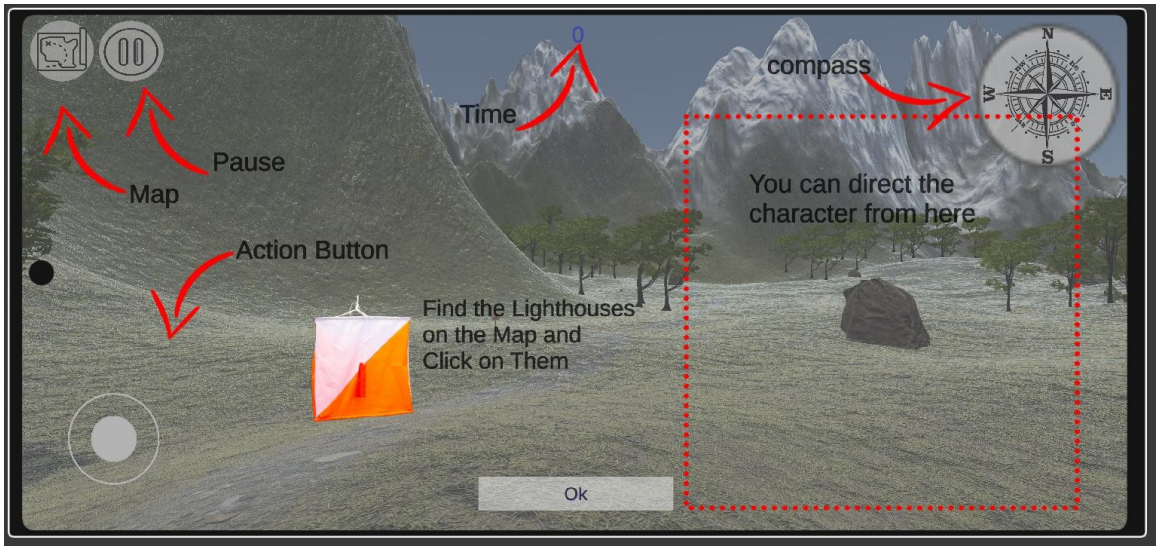

Figure 1. The initial information screen introducing gameplay mechanics and objectives.

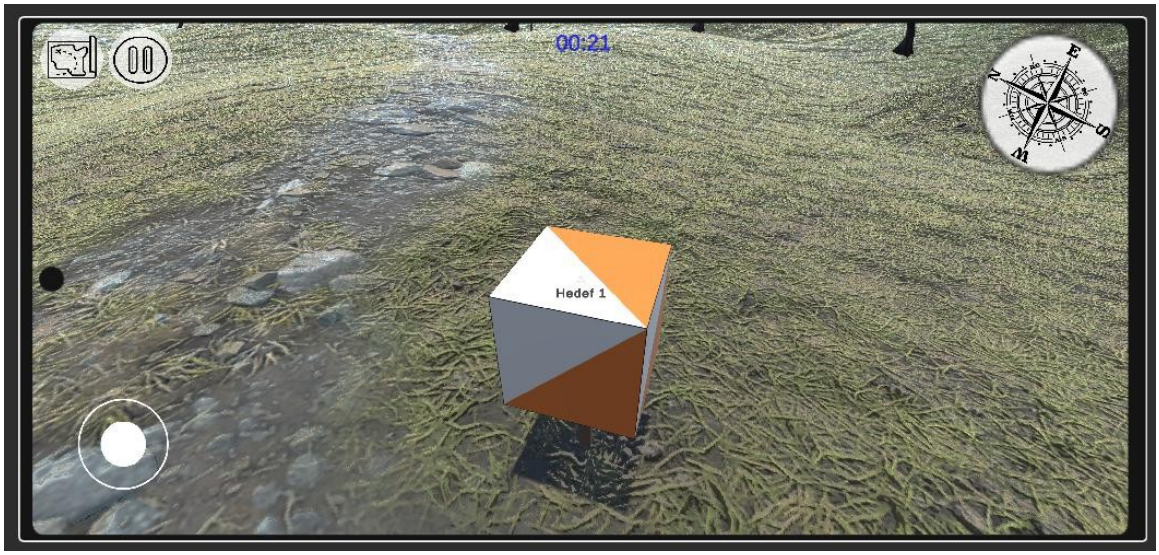

Figure 2. Player interacting with orienteering flags placed in the virtual forest environment.

Once all flags are collected, a narrative element called 'The Story Letter' appears on the screen. This provides story context and motivates the player for the next task (Figure 3).

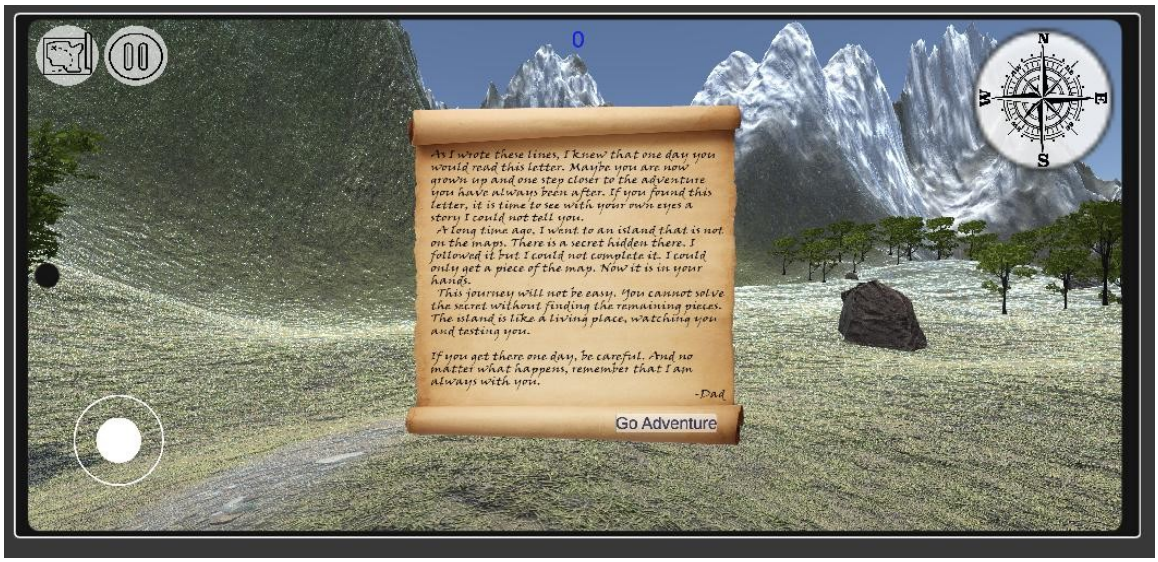

Figure 3. Narrative progression triggered by completing the initial flag collection task.

After the letter is read, a new map is loaded, and the player must collect scattered map fragments throughout the terrain (Figure 4).

Figure 4. The player collecting and assembling map fragments in the new level

When all fragments are assembled correctly, the player is guided to a hidden treasure location, completing the main objective.

Figure 5. The final scene where the player reaches the treasure location

Conclusion

In this study, which was conducted with the awareness of the growing importance of educational game development, a mobile educational game focused on orienteering was designed and implemented. The game was developed in a three-dimensional virtual environment and incorporates interactive missions that simulate real-life orienteering experiences such as map reading, compass navigation, and route planning (Reyes, Aguilar, & Mendoza, 2021; Hermida-Arias & Martínez-Monés, 2025).

Thanks to the integration of educational content within a mobile and interactive game format, the project responds to contemporary demands in the field of digital education. As supported by recent academic literature, game-based learning environments have been shown to increase learner engagement, motivation, and knowledge retention (Plass, Homer, & Kinzer, 2015; Qian & Clark, 2016; Nadeem, Oroszlanyova, & Farag, 2023). The design of the game—combining narrative-driven challenges with intuitive mechanics—supports active learning and contributes to cognitive skill development (Gee, 2003; Ifenthaler, Eseryel, & Ge, 2019).

It is believed that the orienteering educational game developed in this project can attract learners of different age groups by offering an immersive and informative learning experience. The mobile design enables users to engage with orienteering content anytime and anywhere, making it particularly suitable for informal learning and extracurricular use (Sharples, Taylor, & Vavoula, 2015; Alrasheedi, Capretz, & Raza, 2015).

Based on the findings and design outcomes of this project, the following recommendations are proposed for future work:

- Development of multiple difficulty levels to support gradual learning and differentiated instruction,
- Implementation of multiplayer modes to encourage collaborative learning and peer engagement,
- Extension of the game to include diverse terrains (e.g., urban, mountainous, coastal environments) to simulate real-world orienteering complexity,
- Integration with augmented reality (AR) features for hybrid physical-digital navigation experiences,
- Collaboration with educational institutions, particularly physical education and geography departments, to incorporate the game into curriculum and gather broader user feedback,
- Gamification of performance analytics, allowing educators to track learner progress and offer individualized support.

The project has demonstrated that digital games can be used not only for entertainment but also as meaningful tools for education and skill development in outdoor-based sports like orienteering.

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Ethics Approval

Ethics committee approval for this study was received from the Ethics Committee of Isparta University of Applied Sciences - (Date:11 November 2024, Number: 127-09).

REFERENCES

Ali, R., AbdAlgane, M., Youssif, E., Elkot, M. A., & Abbass, D. (2024). Elevating English reading comprehension: The synergy of dialogic teaching and technology integration in ESP learning environments. *International Journal of Information and Education Technology, 14*(8), 1109–1118.

Alrasheedi, M., Capretz, L. F., & Raza, A. (2015). A systematic review of the critical factors for success of mobile learning in higher education (university students' perspective). *Journal of Educational Computing Research, 52*(2), 257–276. https://doi.org/10.1177/0735633115571928

Anderson, T., & Shattuck, J. (2012). Design-based research: A decade of progress in education research? *Educational Researcher, 41*(1), 16–25. https://doi.org/10.3102/0013189X11428813

Aslan, S., & Balci, O. (2015). GAMED: Digital educational game development methodology. *Simulation, 91*(4), 307–319.

Becker, K. (2005). *Games and learning styles*. Proceedings of ICET 2005 Education and Technology Conference.

Cassidy, M., & Gabbard, J. L. (2024). Pedagogical design considerations for mobile augmented reality serious games (MARSGs). *Computers & Education: Artificial Intelligence, 5*, 100156. https://doi.org/10.1016/j.caeai.2024.100156

Eden, C. A., Chisom, O. N., & Adeniyi, I. S. (2024). Harnessing technology integration in education: Strategies for enhancing learning outcomes and equity. *World Journal of Advanced Engineering Technology and Sciences, 11*(2), 001–008.

Gee, J. P. (2003). *What video games have to teach us about learning and literacy*. Palgrave Macmillan.

Hamari, J., Shernoff, D. J., Rowe, E., Coller, B., Asbell-Clarke, J., & Edwards, T. (2016). Challenging games help students learn: An empirical study on engagement, flow, and immersion in game-based learning. *Computers in Human Behavior, 54*, 170–179. https://doi.org/10.1016/j.chb.2015.07.045

Hermida-Arias, M., & Martínez-Monés, A. (2025). OrientaTree: A mobile tool for geolocated educational orienteering. *Interactive Learning Environments*. https://doi.org/10.1080/10494820.2024.2306570

Huang, K.-T., Ball, C., Francis, J., Ratan, R., Boumis, J., & Fordham, J. (2019). Augmented versus virtual reality in education: An exploratory study examining science knowledge retention. *Cyberpsychology, Behavior, and Social Networking, 22*(2), 105–110. https://doi.org/10.1089/cyber.2018.0150

Ifenthaler, D., Eseryel, D., & Ge, X. (Eds.). (2019). *Games and simulations in learning*. Springer.

İnce, E. Y. (2018). Educational games in higher education. *Simulation & Gaming*, 27–39.

Jantakun, T., & Jantakoon, T. (2021). Digital educational computer games environments supporting education (DECGE-SE). *Higher Education Studies, 11*(2), 91–98.

Kucher, T. (2021). Educational game development and implementation: A case study for geography learning. *International Journal of Emerging Technologies in Learning (iJET), 16*(4), 12–25. https://doi.org/10.3991/ijet.v16i04.18539

Liu, L. (2025). Enhancing educational training and learning outcomes through a hybrid experience created by integrating augmented reality and virtual reality technologies. *SAGE Open, 15*(1). https://doi.org/10.1177/14727978241312994

Mayer, R. E. (2019). *Multimedia learning* (3rd ed.). Cambridge University Press. https://doi.org/10.1017/9781139589836

McKenney, S., & Reeves, T. C. (2018). *Conducting educational design research* (2nd ed.). Routledge.

Nadeem, M., Oroszlanyova, M., & Farag, W. (2023). Effect of digital game-based learning on student engagement and motivation. *Computers, 12*(9), 177. https://doi.org/10.3390/computers12090177

Notarnicola, A., Tafuri, S., Acquaviva, A., et al. (2012). Orienteering and spatial orientation: Preliminary analysis of mental representations in beginners. *Journal of Human Sport and Exercise, 7*(2), 360–371.

Plass, J. L., Homer, B. D., & Kinzer, C. K. (2015). Foundations of game-based learning. *Educational Psychologist, 50*(4), 258–283. https://doi.org/10.1080/00461520.2015.1122533

Prensky, M. (2007). *Digital game-based learning*. Paragon House.

Qian, M., & Clark, K. R. (2016). Game-based learning and 21st century skills: A review of recent research. *Computers in Human Behavior, 63*, 50–58. https://doi.org/10.1016/j.chb.2016.05.023

Reyes, M. L., Aguilar, M. L., & Mendoza, F. (2021). Orienteering as a pedagogical resource in physical education to develop spatial orientation. *Journal of Human Sport and Exercise, 16*(4), 875–886. https://doi.org/10.14198/jhse.2021.164.07

Reyes, E., Gálvez, J. C., & Enfedaque, A. (2021). Learning course: Application of gamification in teaching construction and building materials subjects. *Education Sciences, 11*(6), 287.

Sharples, M., Taylor, J., & Vavoula, G. (2015). A theory of learning for the mobile age. In R. Andrews & R. Haythornthwaite (Eds.), *The SAGE handbook of e-learning research* (pp. 63–81). SAGE.

Ting, Y.-L., Tai, K.-H., & Lin, Y.-J. (2020). Designing a user interface for mobile learning: A usability study. *Interactive Technology and Smart Education, 17*(1), 49–67. https://doi.org/10.1108/ITSE-02-2019-0010

Traxler, J. (2018). Learning with mobiles in developing countries. In J. Traxler, M. Mobasher, & R. Kukulska-Hulme (Eds.), *Mobile learning in higher education in the Asia-Pacific region* (pp. 3–14). Springer. https://doi.org/10.1007/978-981-10-4944-6_1

Yiğit, M., & Karatekin, K. (2021). The effect of orienteering applications on students' spatial thinking skills in social studies. *Review of International Geographical Education Online, 11*(3), 765–779. https://doi.org/10.33403/rigeo.784418

Zakaria, A., & Zakaria, N. Y. K. (2024). The impact of digital game-based learning tools on motivation, engagement, and performance in language education: A systematic literature review. *International Journal of Academic Research in Progressive Education and Development, 14*(1). http://dx.doi.org/10.6007/IJARPED/v14-i1/24954