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# Bibliometric Analysis of Global Research Trends on Learning Basic Programming Through Games

## *Analisis Bibliometrik Trend Penyelidikan Global tentang Pembelajaran Asas Programming Melalui Permainan*

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## ABSTRACT

Games' inclusion into programming education has received increased attention due to their ability to improve student engagement, motivation, and problem-solving skills while learning basic programming concepts. Despite the increasing number of publications in this discipline, a thorough grasp of the research landscape, emerging themes, and publication patterns is still lacking. As a result, this research provides a bibliometric overview of research on games in beginning programming instruction. Bibliographic information was obtained from the Scopus database using specific keyword combinations relating to games, game-based learning, and fundamental programming instruction. The analysis looked at publishing trends, top authors, nations, institutions, source titles, number of citation, and keyword co-occurrences. To identify key research clusters and thematic developments, visualization and mapping approaches were used in conjunction with bibliometric tools. The data show a large increase in publications in recent years, indicating a growing scholarly interest in game-based methods to programming instruction. Furthermore, the findings point to emerging research opportunities in adaptive learning, immersive technologies, and game design frameworks for non-computer learners. This research adds to the current literature by offering a thorough examination of the intellectual structure and development trends in games for programming instruction. The findings may help academics, educators, and instructional designers identify research gaps and direct future studies on the development of effective game-based programming learning environments.

*Keywords: Bibliometric; Analysis; Basic Programming; Education; Game.*

## INTRODUCTION

Programming has emerged as a crucial skill in the digital age, forming the basis for computational thinking, problem-solving abilities, and software development. As a result, educational institutions around the globe have progressively incorporated programming courses into their curricula at both school and university levels. Nevertheless, many beginners find learning programming to be difficult due to the abstractness of programming concepts, intricate syntax, and the necessity for logical thinking and problem-solving capabilities. These obstacles frequently lead to diminished motivation, cognitive overload, and elevated dropout rates among novice programmers.

To tackle these challenges, researchers and educators have investigated novel teaching methods that can improve student engagement and learning experiences. One such method is the incorporation of games into programming education. Game-based learning, including educational games, serious games, and gamification, has been widely utilized to establish interactive and stimulating learning environments. Recent research indicates that game-based learning can positively affect students' computational thinking, engagement levels, motivation, and programming success. Additionally, game-based strategies promote active involvement, experimentation, and immediate feedback, which are vital elements in grasping programming concepts.

The increasing significance of computational thinking in modern education has further propelled research into learning programming via games. Numerous systematic reviews and meta-analyses have indicated favorable outcomes of game-based learning on both computational thinking and computer science education. Wang et al. (2023) discovered that game-based learning effectively supports the development of computational thinking, while Ma et al. (2023) noted substantial impacts of game-based learning on computational thinking concepts, skills, and viewpoints. Likewise, Videnovik et al. (2023) emphasized the rising implementation of game-based learning within computer science education due to its capacity to enhance learner motivation and engagement. However, the degree to which these themes have evolved within the broader research context remains uncertain, highlighting the increasing use of educational games, serious games, and gamification techniques in programming courses across various educational tiers. These environments can tailor content, difficulty levels, and learning paths according to individual learner characteristics, potentially enhancing learning effectiveness and engagement, alongside frameworks that better facilitate conceptual understanding and knowledge transfer in educational computing research.

This research contributes to a more systematic and updated analysis to better understand the research landscape of learning basic programming through games. Specifically, this article addressed the following research question:

- RQ1: What is the trend of research on learning basic programming through games published to date?
- RQ2: Which countries contribute significantly to the research of learning basic programming through games?
- RQ3: Who are the most prolific authors on learning basic programming through games?
- RQ4: What are the most influential publications on learning basic programming through games?
- RQ5: What are the main keywords of scientific research on learning basic programming through games?

## LITERATURE REVIEW

Bibliometric analysis is a quantitative method that reviews and analyzes previously published materials (Ellegaard & Wallin, 2015). This methodology can help researchers to evaluate academic articles in a specific field or topic area. This approach includes fair and quantitative review of secondary data from digital sources like Scopus and Web of Science (Verma & Gustafsson, 2020). Implementing a systematic, transparent, and replicable review procedure (Fahimnia et al., 2015; Linnenluecke et al., 2020; Klarin, 2019), this analysis can raise the review's reliability and quality (Dalpé, 2002). In recent years, bibliometric analysis has been employed in educational research to assess published material and

evaluate research performance. These researches have enabled academics and practitioners to better grasp the state of the art in research and forecast the future growth of a specific research field. The academic groups of educational research have increasingly recognized the need of exploring about learning basic programming through games (Tsiotras & Xinogalos, 2021; Sharma et al., 2022; Xinogalos & Satratzemi, 2022; Swacha & Szydłowska, 2023; Tikva & Tambouris, 2023; Hainey & Baxter, 2024).

## METHODOLOGY

In contrast to the earlier bibliometric analysis of scientific journals, books, and conference proceedings, this bibliometric research looked at the articles gathered in the Scopus science database, that has made extensive use of Scopus. 43 research articles' data fields, including source title, abstract, author keywords, year of publication, research area, affiliation, and document format, can be downloaded from Scopus using the Search, Discover, and Analyze tools. Furthermore, many researches consider the Scopus platform to be among the biggest curated databases (Singh et al., 2021; Leydesdorff et al., 2010). Scopus presently has more than 1.7 billion referenced references, according to the newly updated (August 2020) Scopus content coverage guide. As a result, this database can offer a thorough summary of the output of scientific research worldwide (Ishak et al., 2023).

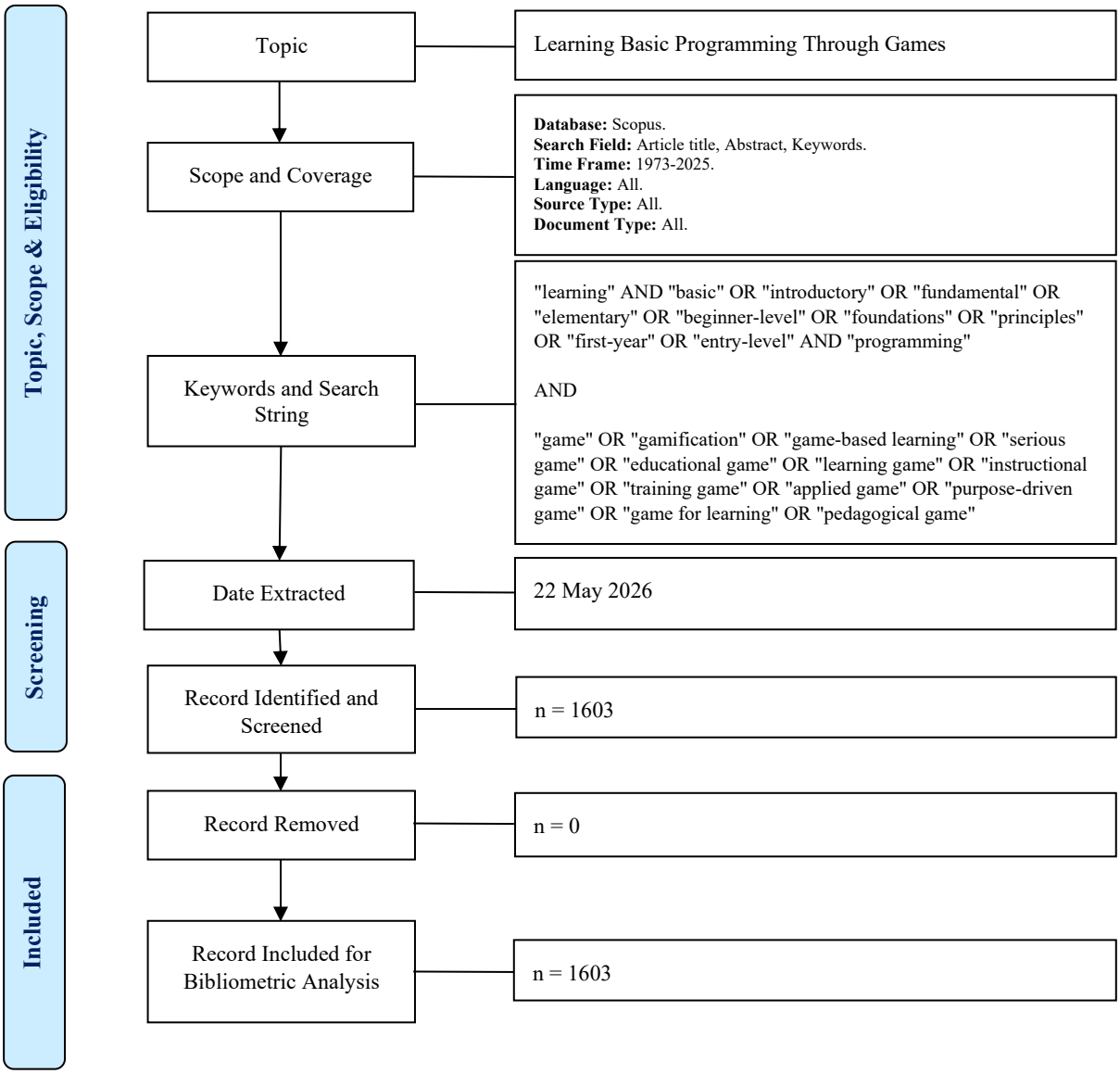


**Figure 1: Flow Diagram of Search Strategy.**
**Source:** Zakaria et al. (2021).

### Search Strategy

A bibliometric analysis was performed through the Scopus database as at 22 May 2026. Due to the year of 2026 has not reach to the end of the year, with around another seven more months to go until the end of 2026, this research excluded the database of year 2026 from the findings in order to showcase the steadily increasing of trend in the research topic of Learning Basic Programming Through Games. The search query title ("learning" AND "basic" OR "introductory" OR "fundamental" OR "elementary" OR "beginner-level" OR "foundations" OR "principles" OR "first-year" OR "entry-level" AND "programming" AND "game" OR "gamification" OR "game-based learning" OR "serious game" OR "educational game" OR "learning game" OR "instructional game" OR "training game" OR "applied game" OR "purpose-driven game" OR "game for learning" OR "pedagogical game") has been performed in the Scopus database to search for relevant publications in any language. As titles serve as the first thing that readers see (Zakaria et al., 2021; Moher et al., 2009), a title-only was used to search strategy to ensure that the found publications are related to learning basic programming through games as the key topic and to prevent a high publication drop-out rate (Kücher & Feldbauer-Durstmüller, 2019). Figure 1 shows the research search strategy. The search retrieved an initial sample of 1603 publications.

## RESULTS AND FINDINGS

For this section, the research status of publications about learning basic programming through games is presented accordingly.

### Trends in Publication

Figure 2 displays the total number of publications and total percentage number of publications on the topic of Learning Basic Programming Through Games. The initial research study was published in 1973. Then, there was an emerging slow-increasing trend till 2003. In 2004, the number of publications on the topic began to grow rapidly. The rise in publication on the topic indicates the awareness of learning basic programming through games is common in school and tertiary education level of students. The academic communities of educational research have progressively acknowledged the importance of researching about learning basic programming through games (Tsiotras & Xinogalos, 2021; Sharma et al., 2022; Xinogalos & Satratzemi, 2022; Swacha & Szydłowska, 2023; Tikva & Tambouris, 2023; Hainey & Baxter, 2024). A sharp rise in publication happened in 2017 (n = 104) when research on the topic grew by 73% to be compared with the year before (n = 60). Taking everything into account, a rapid growth rate was detected in the second decade of the millennium, in which 1426 publications, or 88.96% of all publications were accounted for.

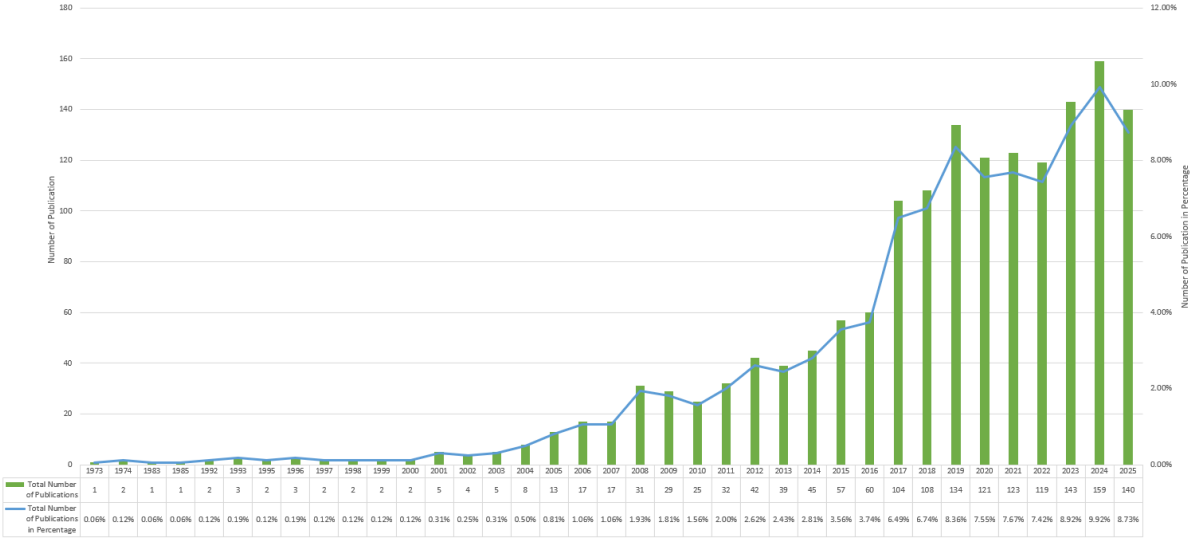


**Figure 2: Trend in Publication of Learning Basic Programming Through Games (1973 - 2025).**

This research also attempts to verify what type of documents for the topic of learning basic programming through games were published through analysing the document types and language data. Table 1 showcases the various types of documents where the publications on the topic have been published. Majority of the publications are conference papers, with 861 publications (53.71% of the total publications). Following the conference papers are journal articles (n = 387, 24.14%), conference review papers (n = 193, 12.04%), books (n = 78, 4.87%), book chapters (n = 59, 3.68%), and review papers (n = 17, 1.06%). For other publications, which include erratum, editorial and retracted documents, each has made up under 1% of all publications. As shown in Table 2, there are five types of sources where the 1603 documents rest within, with 862 documents as conference proceeding (53.77% of total sources), followed with journal (n = 409, 25.51%), book series (n = 210, 13.10%), book (n = 119, 7.42%), and the least source is trade publication with only three publications (0.19% of total sources). Table 3 shows that 97.19% (n = 1558) of learning basic programming through games publications been written in English, indicating that it is the preferred language for the majority of academic research in this field of study.

**Table 1: Document Type.**

| Document Type | Total Publications (TP) | Percentage (%) |
|---|---|---|
| Conference Paper | 861 | 53.71 |
| Article | 387 | 24.14 |
| Conference Review | 193 | 12.04 |
| Book | 78 | 4.87 |
| Book Chapter | 59 | 3.68 |
| Review | 17 | 1.06 |
| Erratum | 6 | 0.37 |
| Editorial | 1 | 0.06 |
| Retracted | 1 | 0.06 |
| **Total** | **1603** | **100** |

**Table 2: Source Type.**

| Source Type | Total Publications (TP) | Percentage (%) |
|---|---|---|
| Conference Proceeding | 862 | 53.77 |
| Journal | 409 | 25.51 |
| Book Series | 210 | 13.10 |
| Book | 119 | 7.42 |
| Trade Publication | 3 | 0.19 |
| **Total** | **1603** | **100** |

**Table 3: Language.**

| Language | Total Publications (TP) | Percentage (%) |
|---|---|---|
| English | 1558 | 97.19 |
| Spanish | 19 | 1.19 |
| Portuguese | 11 | 0.69 |
| Chinese | 9 | 0.56 |
| Russian | 2 | 0.12 |
| Turkish | 2 | 0.12 |
| Korean | 1 | 0.06 |
| Lithuanian | 1 | 0.06 |
| **Total** | **1603** | **100** |

**Publications by Countries**

Table 4 indicates the top 24 countries where most publications on learning basic programming through games are originated. The United States (20.52%) had the leading position, followed by China (5.61%), and United Kingdom (4.68%). The top three publication contributors were diversified to three continents, which are North America, Asia, and Europe. The remaining distribution of author national affiliations was less than 1% and dispersed internationally, demonstrating that learning basic

programming through games is a global research study topic. Figure 3 maps the geographical distribution of total publications by country.

**Table 4: The Top 24 Countries Contributed to the Publications.**

| No. | Country | Continent | Total Publications (TP) | Percentage (%) |
|---|---|---|---|---|
| 1. | United States | North America | 329 | 20.52 |
| 2. | China | Asia | 90 | 5.61 |
| 3. | United Kingdom | Europe | 75 | 4.68 |
| 4. | Greece | Europe | 70 | 4.37 |
| 5. | Germany | Europe | 67 | 4.18 |
| 6. | Brazil | South America | 63 | 3.93 |
| 7. | Spain | Europe | 57 | 3.56 |
| 8. | Canada | North America | 55 | 3.43 |
| 9. | Malaysia | Asia | 46 | 2.87 |
| 10. | Taiwan | Asia | 40 | 2.50 |
| 11. | Indonesia | Asia | 36 | 2.25 |
| 12. | Italy | Europe | 32 | 2.00 |
| 13. | Portugal | Europe | 32 | 2.00 |
| 14. | India | Asia | 31 | 1.93 |
| 15. | Japan | Asia | 28 | 1.75 |
| 16. | Sweden | Europe | 25 | 1.56 |
| 17. | Russian Federation | Europe | 24 | 1.50 |
| 18. | Austria | Europe | 20 | 1.25 |
| 19. | Colombia | South America | 20 | 1.25 |
| 20. | Slovakia | Europe | 20 | 1.25 |
| 21. | Thailand | Asia | 20 | 1.25 |
| 22. | Australia | Oceania | 18 | 1.12 |
| 23. | France | Europe | 16 | 1.00 |
| 24. | Turkey | Europe | 16 | 1.00 |

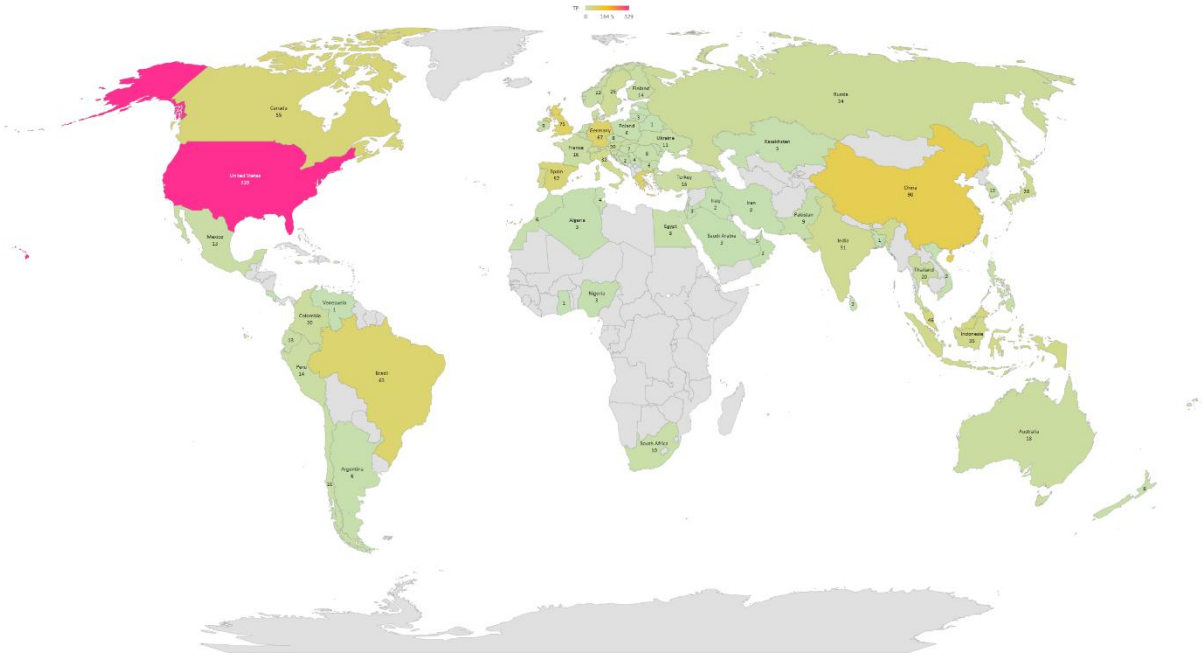

**Figure 3: Geographical Distribution of Publications.**

The co-authorship analysis investigates the formal collaborations between the affiliated countries (Donthu et al., 2021), which resulted in the relationship among countries contributing to the greater clarity and insights of the research topic area. At the same time, it can be used to justify and spark new research among scholars in the underrepresented region. Figure 4 displays the overlay visualisation of

the co-authorship by countries generated by the VOSviewer software. The named country with the largest round radius shape is the leading country, followed by a slightly smaller round radius shape. Thus, it is shown that United States is the leading country marked in green colour which emerged as the most collaborative country, followed by China which is also marked in green colour. This is then followed by United Kingdom and Greece which are marked in yellow colour round radius shape. As a result, the collaborations among authors in specific affiliated countries are diversified across various continents.

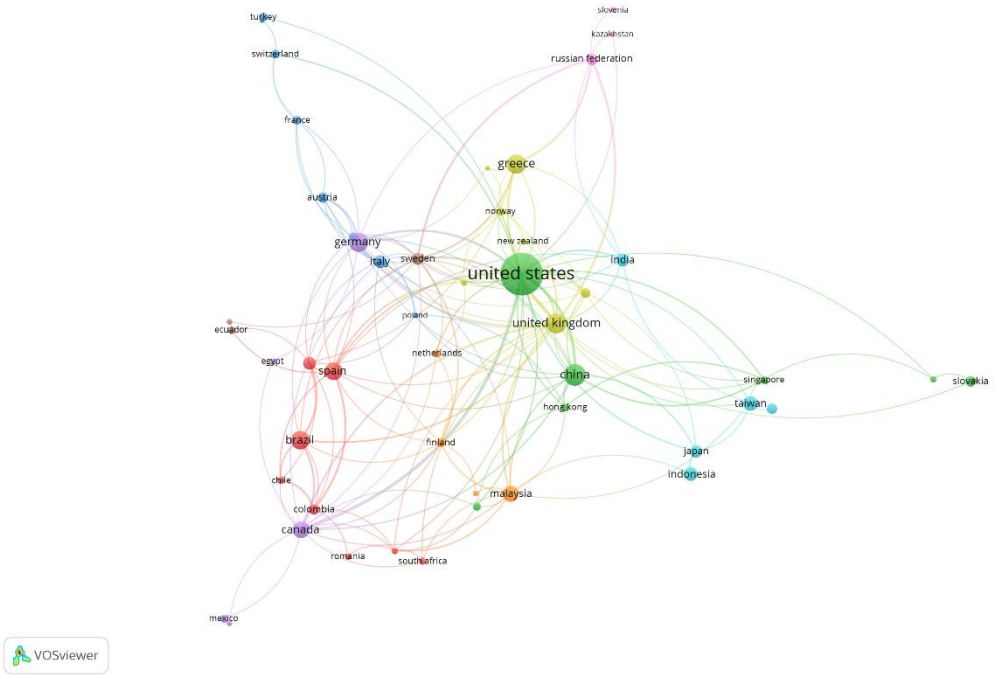


**Figure 4: Overlay visualisation of the co-authorship by countries.**

## Publications by Authors

Table 5 lists the most productive researchers who have published on learning basic programming through games. The list only includes scholars who have published at least 10 documents. The most productive author is Peter Mozelius with 16 publications, affiliated with the Mid Sweden University, Sweden. Meanwhile, Stelios Xinogalos from the University of Macedonia in Greece ranks second place on the list of the most prolific authors who have contributed the most, with 15 publications.

**Table 5: Top Authors Contributing to Learning Basic Programming Through Games Research.**

| No. | Author's Name | Affiliation | Country | Total Publications (TP) |
|---|---|---|---|---|
| 1. | Mozelius, P. | Mid Sweden University | Sweden | 16 |
| 2. | Xinogalos, S. | University of Macedonia | Greece | 15 |

## Publications by Source Title

Table 6 list three journals that published at least 50 papers in the field of learning basic programming through games. Note that the most productive source of journal is ACM International Conference Proceeding Series with 62 total publications in the field. It is then followed by Proceedings of the European Conference on Games Based Learning with 56 publications, and Proceedings Frontiers in Education Conference Fie with 51 publications.

**Table 6: Most Active Source Titles.**

| No. | Source Title | Total Publications (TP) |
|---|---|---|
| 1. | ACM International Conference Proceeding Series | 62 |
| 2. | Proceedings of the European Conference on Games Based Learning | 56 |
| 3. | Proceedings Frontiers in Education Conference Fie | 51 |

**Publications by Citations**

To determine the most influential articles in the field of learning basic programming through games research domain, a list of top five most cited publications is tabulated in Table 7. Note that a research based on a nationwide poll by Dung P.M. (1995) regarding On the Acceptability of Arguments and its Fundamental Role in Nonmonotonic Reasoning, Logic Programming and N-Person Games is the most cited article with 4100 citations. With 1736 citations, a paper by Shoham Y., & Leyton-Brown K. (2008) about the multiagent systems on algorithmic, game-theoretic, and logical foundations has the second-highest number of citations. The third highest citation, with 384 citations, is an article focusing on the impact of gamification on students' learning, engagement and behavior based on their personality traits by Smiderle R., Rigo S.J., Marques L.B., Peçanha de Miranda Coelho J.A., & Jaques P.A. (2020). This is followed by Fessakis G., Gouli E., & Mavroudi E. (2013) with the article on a case study about problem solving by five to six years old kindergarten children in a computer programming environment, with 357 citations, and Ng D.T.K., Lee M., Tan R.J.Y., Hu X., Downie J.S., & Chu S.K.W. (2023) with the article on a review of artificial intelligence (AI) teaching and learning from 2000 to 2020, with 326 citations. Most of the publications on the topic of learning basic programming through games are in the subject area of Computer Science, followed by Social Sciences, Engineering, Mathematics, and Decision Sciences respectively.

**Table 7: Top Five Highly Cited Articles.**

| No. | Authors | Title | Total Citations |
|---|---|---|---|
| 1. | Dung P.M. (1995) | On the Acceptability of Arguments and its Fundamental Role in Nonmonotonic Reasoning, Logic Programming and N-Person Games. | 4100 |
| 2. | Shoham Y., & Leyton-Brown K. (2008) | Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations. | 1736 |
| 3. | Smiderle R., Rigo S.J., Marques L.B., Peçanha de Miranda Coelho J.A., & Jaques P.A. (2020) | The Impact of Gamification on Students' Learning, Engagement and Behavior Based on Their Personality Traits. | 384 |
| 4. | Fessakis G., Gouli E., & Mavroudi E. (2013) | Problem Solving by 5-6 Years Old Kindergarten Children in a Computer Programming Environment: A Case Study. | 357 |
| 5. | Ng D.T.K., Lee M., Tan R.J.Y., Hu X., Downie J.S., & Chu S.K.W. (2023) | A Review of AI Teaching and Learning from 2000 to 2020. | 326 |

**Top Keywords**

This research provides the co-occurrence analysis of the author's keywords in order to determine the primary keywords of scientific research. Table 8 lists the top 30 author keywords. The most top author's keyword is students, followed with teaching, computer programming, education computing, and computer games. These top five keywords are the primary terms or phrases that encapsulate the core concepts of the research topic on learning basic programming through games. Figure 5 depicts the the overlay visualisation of the co-occurrence by all keywords generated by the VOSviewer software. It is shown that keyword of students has the largest round radius shape marked in purple coulour.

**Table 8: Top 30 Author's Keywords.**

| No. | Author Keyword | Total Publications (TP) |
|---|---|---|
| 1. | Students | 592 |
| 2. | Teaching | 317 |
| 3. | Computer Programming | 255 |
| 4. | Education Computing | 250 |
| 5. | Computer Games | 210 |
| 6. | Learning Systems | 208 |

| No. | Author Keyword | Total Publications (TP) |
|---|---|---|
| 7. | Gamification | 198 |
| 8. | E-learning | 196 |
| 9. | Curricula | 192 |
| 10. | Education | 188 |
| 11. | Engineering Education | 178 |
| 12. | Game-based Learning | 178 |
| 13. | Programming | 161 |
| 14. | Computational Thinking | 127 |
| 15. | Serious Games | 127 |
| 16. | Computational Thinkings | 126 |
| 17. | Computer Aided Instruction | 103 |
| 18. | Game Design | 103 |
| 19. | Game Theory | 103 |
| 20. | Human Computer Interaction | 100 |
| 21. | Motivation | 94 |
| 22. | Educational Game | 89 |
| 23. | Programming Concepts | 87 |
| 24. | Software Design | 86 |
| 25. | Programming Education | 74 |
| 26. | Introductory Programming | 72 |
| 27. | Problem Solving | 70 |
| 28. | Computer Science Education | 68 |
| 29. | Robot Programming | 66 |
| 30. | Artificial Intelligence | 64 |

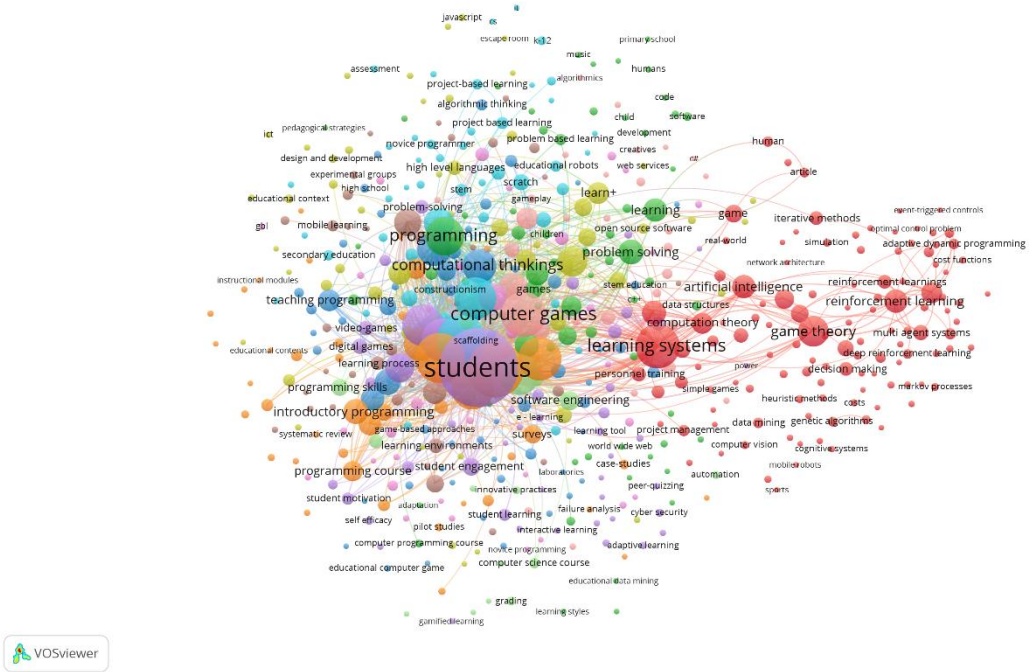


**Figure 5: Overlay visualisation of the co-occurrence by all keywords.**

## DISCUSSIONS

The results indicate a significant increase in research concerning the teaching of basic programming through games over the past fifty years. While the first relevant publication dates back to 1973, this area remained relatively under-researched until the early 2000s. The sharp rise in publications after 2004, notably the spike in 2017, signifies a growing academic and educational interest in utilizing game-based methods within programming instruction. This trend aligns with the increasing acknowledgment of

programming as a vital digital literacy skill and the widespread use of educational technologies in both primary and higher education settings. Recent research has consistently emphasized the benefits of game-based learning and gamification in boosting students' motivation, engagement, and success in programming, possibly accounting for the ongoing expansion of research in this area.

The prevalence of conference papers (53.71%) and conference proceedings (53.77%) indicates that the field is both dynamic and influenced by technological advancements. Researchers tend to favor conferences as platforms for sharing their findings rapidly, which allows for the quick dissemination of innovations and educational technologies. This trend is typical in computer science and educational technology fields, where rapid technological progress is common. However, the lower ratio of journal articles suggests an opportunity for more thorough longitudinal and empirical studies that could provide stronger evidence regarding the effectiveness of game-based programming education initiatives.

Language analysis shows that English is overwhelmingly the dominant language in academic publications, comprising 97.19% of all entries. This trend aligns with global academic publishing practices, where English serves as the primary language for international research dissemination. Although this predominance aids global knowledge sharing, it may also restrict the visibility of research conducted in non-English-speaking regions and create obstacles for researchers and practitioners who may not be proficient in English.

Country-level analysis reveals a global distribution of research contributions, with the United States leading with 20.52% of total publications. The strong presence of countries such as China, the United Kingdom, Greece, Germany, Brazil, and Malaysia underscores the international significance of learning basic programming through games. The rise of several Asian nations, including Malaysia, Taiwan, Indonesia, India, and Japan, indicates a growing regional interest in innovative approaches to programming education. Malaysia's placement among the top ten contributing countries further highlights the increasing dedication of local researchers to advancing educational technology and programming pedagogy.

Examination of the most productive authors shows that contributions are relatively spread out, with the most prolific authors having only 15 to 16 publications. This pattern suggests that the field is not dominated by a small group of leading scholars but instead involves a wide array of contributors from various institutions and countries. Such diversity may promote interdisciplinary collaboration and facilitate the development of different perspectives on game-based programming education.

The source title analysis indicates that the most productive publication outlets are conference-oriented, particularly the ACM International Conference Proceeding Series and the Proceedings of the European Conference on Games Based Learning. This finding reinforces the idea that learning basic programming through games is an evolving field characterized by ongoing experimentation, technological innovation, and pedagogical progress.

Citation analysis reveals a notable limitation in the literature retrieval process. Although the most cited publications exert significant influence, several of the top-cited works related to argumentation theory, multiagent systems, and game theory do not focus directly on learning basic programming through educational games. This suggests that the search strategy may have included publications associated with the broader concept of "games" rather than those specifically in educational gaming contexts. Nevertheless, the inclusion of highly cited studies related to gamification, programming education, and educational technology implies that learner engagement, motivation, and computational thinking remain central themes in this field.

Keyword analysis offers additional insights into the intellectual framework of the research domain. The prominence of keywords such as students, teaching, computer programming, education computing, and computer games confirms the educational focus of the field. Moreover, the frequent appearance of terms such as gamification, game-based learning, computational thinking, serious games, motivation, and

problem-solving indicates that researchers increasingly regard games as pedagogical tools capable of promoting higher-order thinking skills and enhancing learning outcomes. The emergence of artificial intelligence among the top keywords may also reflect a growing interest in integrating AI-driven technologies into future game-based programming learning environments.

In summary, the findings illustrate that learning basic programming through games has matured into a widely recognized research area. The upward trend in publications, international participation, and diverse thematic foci collectively suggest a strong research momentum. Future studies may benefit from investigating personalized game-based learning experiences, the integration of artificial intelligence, adaptive learning systems, and game design frameworks tailored for learners outside the computer science and creative disciplines.

## CONCLUSION

This bibliometric analysis offers a thorough overview of research trends in learning basic programming through games from 1973 to 2025. The findings indicate a notable rise in academic publications, especially in the last decade, reflecting an increasing acknowledgment of game-based learning as an effective method for programming instruction. The predominance of conference papers and proceedings highlights the technology-driven and rapidly changing nature of the field.

The analysis also shows that research contributions are sourced from a wide array of countries, with the United States leading in publication output, followed by several nations across Asia and Europe. English continues to be the primary language of publication, facilitating the global dissemination of knowledge. Identifying influential authors, publication venues, and highly cited works provides valuable insights into the intellectual landscape of the field.

Keyword analysis reveals that major research themes center around students, teaching, computer programming, game-based learning, gamification, computational thinking, motivation, and serious games. These insights confirm that the field's primary aim is to enhance programming education through engaging and interactive learning experiences.

This research contributes to the understanding of the evolution and current landscape of research on learning basic programming through games. The findings may serve as a valuable reference for researchers, educators, instructional designers, and policymakers looking to promote innovative programming education practices. Future research should focus on developing evidence-based game design frameworks, assessing long-term learning outcomes, and exploring emerging technologies such as artificial intelligence, adaptive learning systems, and immersive environments to further enhance the effectiveness of game-based programming education.

The bibliometric evidence suggests that research on game-based programming education is progressively expanding from conventional game-based approaches toward technologically enhanced and learner-centred environments. This development is reflected in the substantial growth of publications, with 88.96% of the identified publications appearing during the second decade of the millennium, and in the diversity of keywords associated with learning systems, e-learning, gamification, serious games, human-computer interaction, and artificial intelligence. Within this broader evolution, adaptive learning and immersive technologies can be interpreted as emerging research directions rather than established dominant themes. The study identifies adaptive learning systems, personalized game-based learning, and immersive environments as areas requiring further investigation, while recent cited studies demonstrate the application of augmented reality and extended-reality approaches to programming education. Thus, the findings suggest a transition from primarily engagement-oriented game-based programming research toward more personalized, intelligent, and immersive learning environments.

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