



Bibliometric analysis of swimming learning models for students (2002-2024): Trends, gaps, and future directions

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Abstract: Drowning during swimming has become a significant public health concern that urged the World Health Organization to call for all school-aged children to be taught basic swimming skills, water safety, and rescue techniques. In this teaching, efficiency shall be obtained with the help of an effective learning model. This study will investigate the publication trends of research about swimming learning models carried out for students during the last 22 years, from 2002 until 2024, using the data from the Scopus database. The search was carried out on August 7, 2024, by title, abstract, and keywords, using the sets of words "swimming AND learning AND model AND for AND students," and obtained 47 documents, where 66% were articles, 12.8% conference reviews, 10.6% conference papers, 4.3% book chapters, 2.1% books, 2.1% notes, and 2.1% reviews. The most frequent year of publication corresponded to the year 2023, with a total of 10 documents. Three each by the International Journal of Human Movement and Sport Science and Emerald Emerging Markets Case Studies. Among the 15 contributing authors, only two documents were contributed by Firmansyah Dlis and Mao Jie. Affiliation-wise, two were contributed by Universitas Negeri Yogyakarta, Wuhan Sports University, Universitas Negeri Surabaya, and Universitas Negeri Jakarta. Nationally, China tops the list with eight documents. The most cited article, by Iserbyt et al. (2016), received 44 citations in 22 years. Based on the VOSviewer analysis, the "swimming learning model" item count is low (47 documents in 22 years). Thus, the visualization has been limited, with only a few networking-connected words. Such a scenario represents that research on swimming learning models for students still holds potential for further investigation.

Keywords: swimming learning model, teaching swimming, swimming skills, swimming safety, bibliometric

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INTRODUCTION

Among all water sports, swimming is considered the most popular sport in the world. Swimming is one of the most popular sports in the United States because water sports and games are within the reach of almost every person there, making it one of the most common sports for recreation purposes (Syahrastrani, 2022). Students enjoy swimming more than any other sport because it involves playful activities inherent in each student (Nurdiansyah et al., 2023). It is appreciated that the current trend within physical education has been associated not only with the development of improved motor skills among students but also and above all, with preventing the health problems of adolescents (Bielec & Saklak, 2013), including obesity and postural defects. It thus means that the experiences of swimming as a lifelong physical activity, if initiated at adolescent levels, contribute to the beneficial impacts of adulthood. These include sustainable stays through outdoor swimming and water safety (Lundhaug, 2024), and a drop in the rate of drowning upon incidences involving water (Mashud et al., 2023; Pharr et al., 2018; Sundan et al., 2024). Besides improving one's motor skills, swimming develops independence, discipline, and good overall health (Pebriyandi & Mashud, 2024); it is also counted as a means of creating fun in life for an individual (Sundan et al., 2024).



While swimming has been considered one of the fun sports activities for students, it does not mean that swimming is also accessible from various problems. When teachers, parents, or students are negligent in supervising the swimming event, the activity may be a huge problem for children. The biggest challenge for teachers and students in swimming education is that students often lack the courage to learn how to swim due to a high fear of water (Sukur et al., 2018), especially among female students (Ostrowski et al., 2022). The low interest of students in freestyle swimming, as depicted by the research by Sin and Hudayani (2020), among 33 percent of the students, the lessons in swimming are assessed as dull (Bielec & Saklak, 2013). Depict, fear, the lack of interest among the students, and learning in a dull environment can jeopardize the participation and skills of the students in swimming lessons. In acquiring and perfecting various aquatic skills, however, students can reduce the risk of drowning during water activities by 88% for children aged 1-4 years and 64% for children aged 5-19 years (McIntosh, 2009). It speaks to the fact that students who are sensitive to aquatics-skilled swimmers are a necessity in preventing drowning (Sundan et al., 2024) because they can train their breathing abilities effectively (Ginting et al., 2021).

The World Health Organization says all school-aged children should be taught basic swimming, water safety, and rescue skills (Petrass et al., 2021). Teachers should encourage students to take risks and adapt to these conditions to enhance their water safety awareness. Learning to cope with variation enhances their ability to manage changes and explore learning opportunities even in unexpected situations (Lundhaug, 2024). Aquatic competency and preventing drowning among students result from them learning to swim through a structured program (Peden & Franklin, 2020; Stallman et al., 2008). Regarding this, a variety of teaching methods have been used to drift the skills of students in swimming, some of which are guided through the use of swimming boards (Sin & Hudayani, 2020), using video feedback teaching methods that work to enhance student movement and technical competence, including in general, enhancing the quality of instruction in swimming (Ma, 2021). Other proposed methodologies include the ISLAMT2E strategy: Instructing, Saving, Learning, Analyzing, Measurement, Group Task, Individual Task, Evaluation, based on a static swimming tool (Ginting et al., 2021) learning model of peer tutoring (Abidin, 2021), CS 6 flash-based swimming learning model (Zulkifli et al., 2023); and STAD learning model (Syahrudin et al., 2023).

The studies mentioned above are still limited in providing enough references for teachers conducting swimming lessons. It is attributed to the fact that only some teachers can conduct swimming classes because of concern over various safety risks associated with the students' experience during swimming classes (Hermawan et al., 2022). These experiences associated with students in swimming might occur in unsafe places (Bielec & Saklak, 2013) or involve children with special needs (Carter & Koch, 2022; Desianti et al., 2021). While drowning prevention is well-studied, few studies have systematically mapped pedagogical models for swimming education. Mentioning that Aristizabal et al. (2022), in their bibliometric study, stated there has been increased production of scientific documents in the period covering 2010 to 2020 for swimming. That study did not, however, mention the learning models to which swimming instruction refers. Furthermore, few studies have systematically mapped pedagogical models for swimming education. Therefore, this research is conducted to cover the gaps in the previous studies concerning the implementation of swimming learning models published in international journals indexed in reliable databases such as Scopus. In the end, this research output is expected to provide information, experience, and referential study for other researchers and practitioners in conducting training to improve the students' swimming skills more effectively and efficiently.

METHOD

To address the research problem, this study adopts a bibliometric approach, as it allows researchers to analyze large datasets quickly and accurately and provides practical interpretations of keyword metrics and title and abstract analysis (Blegur & Hardiansyah, 2024). Bibliometric studies assist researchers in advancing knowledge and technology in a specific field while also helping to project meaningful future research directions (Blegur et al., 2023; Donthu et al., 2021; Mejia et al., 2021; Razali et al., 2024). Moreover, this method can identify current research opportunities and updates, enabling a more significant contribution to the development of future science and technology (Blegur et al., 2023; Blegur, Mulyana, et al., 2024; Marmoah et al., 2022).

The investigation was conducted on August 7, 2024, beginning with the research procedure through study determination, data inspection, data importing, data analyzing, and data reporting (see Figure 1). First, the researcher defined "*swimming AND learning AND model AND for AND students*" in the Scopus search engine under the article title, abstract, and keyword sections to clarify the research objectives. Second, the Scopus database inspection from 2002-2024 identified 47 documents: 31 articles, six conference reviews, five conference papers, two book chapters, one book, 1 note, and one review. The time span from 2002 to 2024 was selected to provide a comprehensive overview of two decades of research development in swimming teaching models. The starting year of 2002 was chosen because it marked the earliest publication indexed in Scopus that explicitly addressed swimming teaching models, ensuring that no relevant earlier studies were excluded. The endpoint of 2024 was determined to include the most recent studies available at the time of data collection, thereby capturing the latest research trends and methodological advancements. These 47 selected documents span 20 subject areas, including social sciences, health professions, medicine, computer science, engineering, and others. Third, the inspection results (47 documents) were imported from Scopus into Comma Separated Values (CSV) format to perform data metrics (such as frequency and percentage) on documents by year, source, author, affiliation, country, and by type.

Study determination	Data inspection	Data importing	Data analysing	Data reporting
<ul style="list-style-type: none"> • Determine the title, abstract, and keywords "swimming AND learning AND model AND for AND students" • Establish an inspection platform using the Scopus database • Set time for data collection on 7 Agustus 2024 	<ul style="list-style-type: none"> • Inspect and verify 47 published document from the Scopus database for 2002-2024 • Operate analysis in the Scopus application to record publication metrics (document by years, by sources, by authors, by affiliation, by country, and by type) 	<ul style="list-style-type: none"> • Import Scopus data inspection results into CSV format to perform data metrication • Import Scopus data inspection results to CSV format to simplify the calculation of publication metrics using visualization using VOSviewer 	<ul style="list-style-type: none"> • Analyse publication trends Metrics (document by years, by sources, by authors, by affiliation, by country, and by type) • Analyse CSV format data visualizations using VOSviewer (network, overlay, density) 	<ul style="list-style-type: none"> • Report and discuss publication metrics (trends) in format JPEG • Report and discuss VOSviewer data visualizations (network and overlay) in image format PNG

Figure 1. Research flow

The scopus analysis on "*swimming AND learning AND model AND for AND students*", was done based on years, sources, authors, affiliation, country, and document type; then, the data was saved in JPEG format. The final analysis used the VOSviewer application from data in CSV format, detecting citation trends from units of analysis (see Tables 2 and 3); network visualization and overlay of publication trend keywords (see Figure 8); titles and abstracts (see Figure 9). According to Jan van Eck & Waltman (2010), bibliometric studies were chosen since one could quickly develop interpretations of large bibliometric maps through graphic displays. Thus, the 47-document analysis—each document having article titles, abstracts, and keywords related to "*swimming AND learning AND model AND for AND students*"—will be much easier to operate through VOSviewer. Also, the researcher can interpret output visualizations more easily, like network, overlay, and density maps.

The ease of interpreting VOSviewer visualization outputs is described as follows: First, network visualization, where items are represented by their labels (either as default labels or circles). The size of the label and circle is determined by the item's weight. The distance between two items in the visualization indicates their relationship (items placed closer together reflect a stronger connection). Second, overlay visualization, where if an item has a score, the item's color is determined by that score. By default, the color ranges from blue (lowest score) to green, then yellow (highest score). Third, density visualization, which shows the density of items at specific points. By default, the color ranges from blue,

green, to yellow. The more items present near a point and the higher the weight of surrounding items, the closer the color of that point is to yellow (Jan van Eck & Waltman, 2023).

The final step (fifth) involves the researcher reporting and discussing the citation metric data using Publish or Perish (PoP) in table format. The researcher also reports and discusses the publication trend metrics related to online assessment in physical education using bar charts and pie charts (in JPEG format) and further reports and discusses the VOSviewer visualization outputs in image format (PNG), including both network and overlay visualizations.

RESULT AND DISCUSSION

Publication Trends

Document by years

Scopus Search by title, abstract, and keyword was performed using *"swimming AND learning AND model AND for AND students,"* which resulted in 47 documents from 2002 to 2024. The publication trends over the past 10 years have been: 1 document in 2014, no documents in 2015, 4 documents in 2016, 2 documents in 2017, 3 documents in 2018, 2 documents in 2019, 2 documents in 2020, 6 documents in 2021, 3 in 2022, 10 in 2023, and 7 in 2024 so far. Figure 2 represents the fact that 2023 had the highest number of publications with 10 documents. This data also shows a rapid growth of articles within these past ten years, at an average of 4 articles published within a year.

One of the recent articles on the learning model of swimming among students is *"Impact of a physical education teacher's age on elementary school students' perceptions of effectiveness and learning,"* published Pennington et al. (2019). The study found that students who viewed the younger-looking teachers scored significantly higher on exams and rated the individual teachers as likable, competent, and better role models than those who viewed middle-aged teachers. The surge in publications in 2023 was largely driven by the post-COVID-19 context, which spurred heightened interest in adaptive and innovative learning models. This trend is particularly evident in physical education domains such as swimming, which had been severely affected by prior social restrictions. In response, various institutions have begun to explore technology-enhanced instructional approaches, including blended learning and cognitive-motor simulations, to support the teaching and learning of swimming.

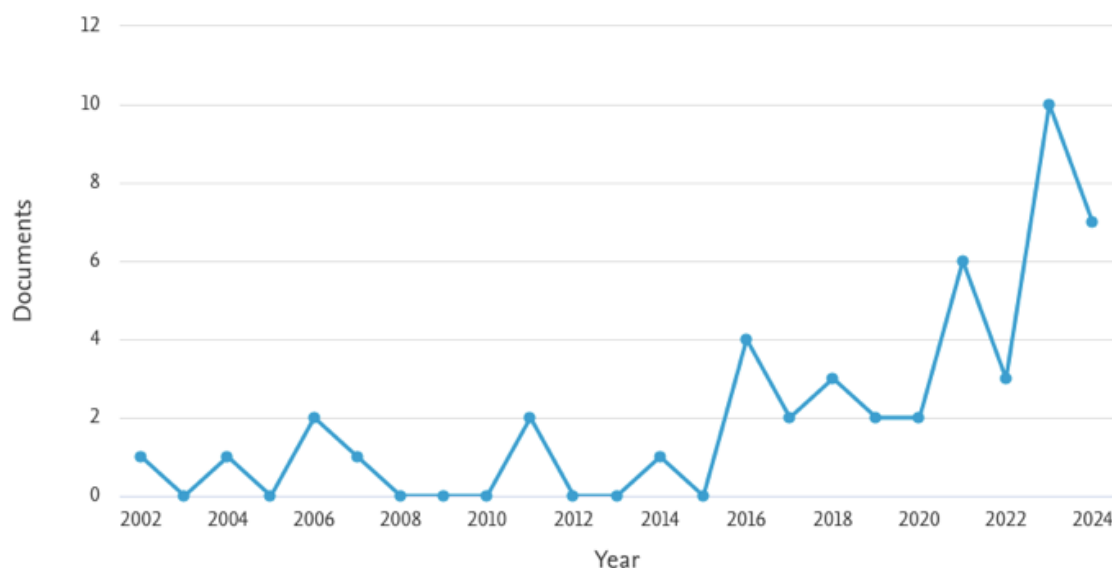


Figure 2. Document by years

Document per years by source

Overall, 33 publishers (sources) published 47 documents from 138 authors. Thirty-three publishers published articles from the lowest range (1 document) to 3 documents. In detail, 29 publishers only published 1 document, and two publishers managed to publish three documents. The publishers managed to publish two documents, namely Education Science and Physical Education and Sport

Pedagogy, and the highest is the publisher of the International Journal of Human Movement and Sport Science and Emerald Emerging Market Case Studies, which managed to publish three documents in 2002-2024, can be seen in Figure 3. One of them, the International Journal of Human Movement and Sport Science, published an article entitled: *"Freestyle swimming (crawl) learning model for autistic children in elementary school,"* written by Sugiharto et al. (2023) and from Emerald Emerging Market Case Studies published an article entitled: *"TopSteel: Swimming sustainably in the blue metal ocean"* written by Kong et al. (2021).

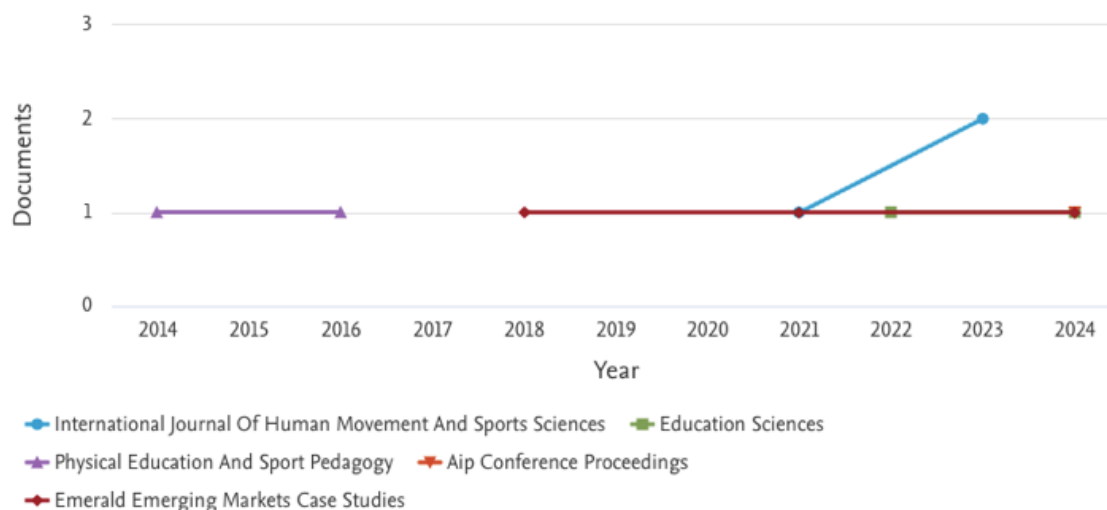


Figure 3. Document per years by source

Document by authors

One hundred thirty-eight authors contributed to the publication of 47 documents. However, only two authors contributed to the publication of the swimming learning model for students as many as two documents, Firmansyah Dlis and Mao Jie, respectively (see Figure 4). This issue underscores the need to develop a more cohesive research community, as the current fragmentation and lack of sustainable expertise continue to hinder scientific progress and innovation in swimming learning models. The absence of collaboration, limited researcher regeneration, and insufficient skills renewal contribute to stagnation in the field. To foster adaptive and competitive research capacity, cross-disciplinary integration and the strengthening of the research ecosystem are essential.

Firmansyah Dlis was also involved in a collaborative publication entitled *"Freestyle swimming (crawl) learning model for autistic children in elementary school,"* published by Sugiharto et al. (2023) in the International Journal of Human Movement and Sports Sciences, volume 11, issue 3, pages 668-675, May 2023. Then Dlis was also involved in another collaborative publication titled *"Effectiveness of teaching style: An alternative breaststroke swimming learning model in higher education,"* written by Mardesia et al., (2021) in the International Journal of Human Movement and Sports Sciences, volume 9, issue 6, pages 1236-1243, October 2021.

The next author, Mao Jie, published a collaborative publication with the title *"The application of diversified multimedia techniques in swimming courseware"* in the Proceedings of the 2011 International Conference on Future Computer Science and Education, ICFCSE 2011, pp. 259-262, 6041710 (Jie & Yiyun, 2011). Jie (2011) also published an independent publication entitled *"Development of diversified 3D analogue simulation teaching courseware in swimming education"* in the 2011 International Conference on Consumer Electronics, Communications, and Networks, CECNet 2011 - Proceedings, pp. 268-271, 5768665.

Furthermore, other authors only managed to publish 1 document, three of which are. First, Flud et al. (2023) wrote one of their articles entitled *"Functional frogs: Using swimming performance as a model to understand natural selection and adaptations."* Second, Bender et al. (2021) published an article by the first author, *"When and how seductive details harm learning. A study using cued retrospective reporting."* Third, Usra et al. (2021), in the article titled *"Swimming exercise model policy using straps as an aid for beginners."*

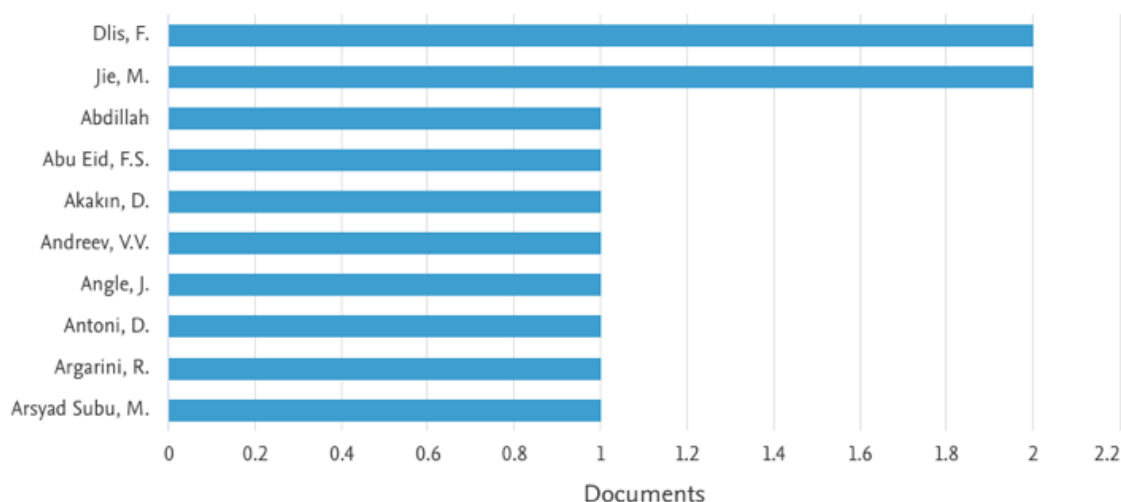


Figure 4. Document by authors

Document by affiliation

Universitas Negeri Yogyakarta, Wuhan Sports University, Universitas Negeri Surabaya, and Universitas Negeri Jakarta dominated the publication of documents titled Swimming Learning Model for Students, with two from other affiliations. Sequentially below, The Hamble School Sport Partnership contributed 1 document, Volga Region State Academy of Physical Culture managed to contribute 1 document, IKIP PGRI Pontianak contributed 1 document, Iqra Buru University contributed 1 document, Universitas Muhammadiyah contributed 1 document, and Dubai Medical Journal contributed 1 document, can be seen in Figure 5.

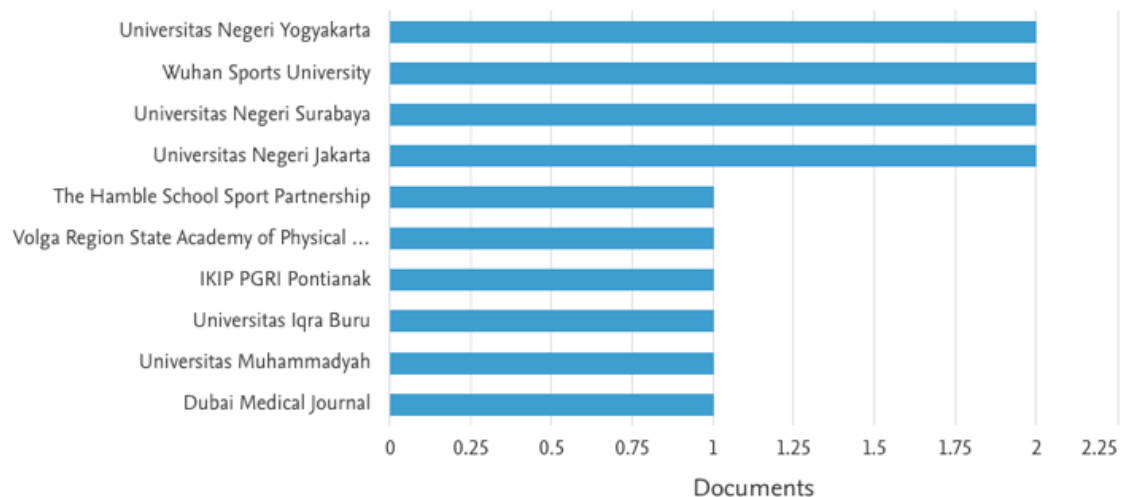


Figure 5. Document by affiliation

In addition, the College of Health Sciences STIKES, the Universitas Sriwijaya, and Madian Town Center Primary School each contributed 1 document. Other affiliates also managed to contribute documents for the publication of swimming learning models for students, 1 document each, including other universities in Indonesia such as Universitas Cendrawasih, Universitas Negeri Medan, Universitas Negeri Padang, Universitas Lambung Mangkurat, Universitas Tanjungpura, and Universitas Airlangga.

Document by country

The top ten countries that contributed to the publication of swimming learning models for students, France, Belgium, and Barbados, contributed 1 document each, followed by Poland and Australia contributed two documents each, then the United Kingdom and Malaysia contributed three documents each, the United States and Indonesia contributed six documents each, and the highest was

China contributed eight documents, can be seen in Figure 6. One of the articles from China related to SLM (swimming learning model) entitled *"Research on teaching model of swimming skills training in colleges and universities under the background of artificial intelligence"* was written by (Xu, 2024). Indonesia contributed to the publication of six documents, namely, student swimming learning models. One of the Indonesian authors who contributed was Mardesia et al. (2021) from Universitas Negeri Jakarta, who published an article entitled *"Effectiveness of teaching style: An alternative breaststroke swimming learning model in higher education."* The study concluded that an inclusive teaching style positively impacts learning outcomes for breaststroke swimming. Using an inclusive teaching style, students can choose the desired level of learning based on their abilities. This study's results provide significant implications as an alternative to improve the effectiveness of breaststroke swimming learning in university students.

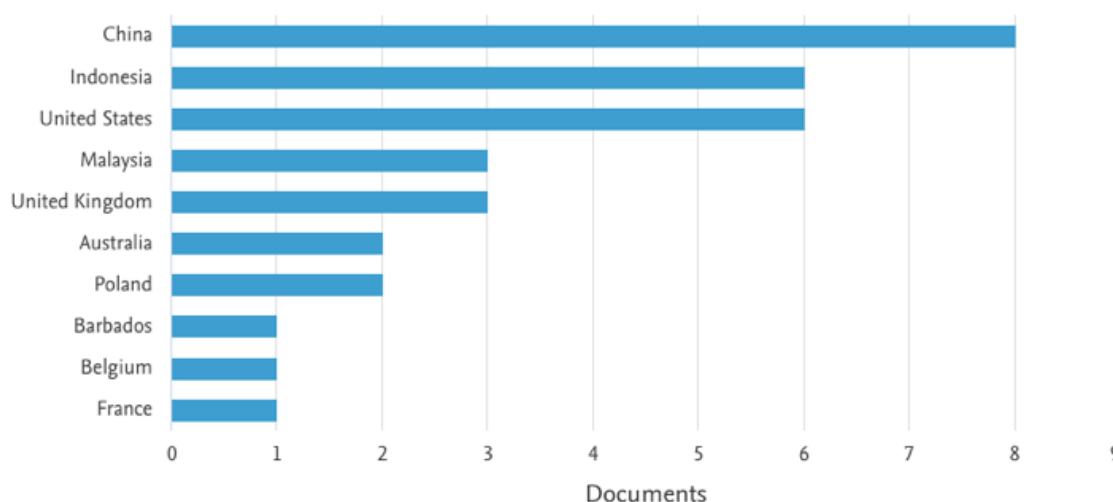


Figure 6. Document by country

Document by type

Of the 7 document types published, book, note, and review have the lowest number with 1 document each (2.1%), followed by book chapter with two documents (4.3%). Conference papers with five documents (10.6%), conference reviews with six documents (12.8%), and the highest is article type with 31 documents (66%), as can be seen in Figure 7. In the following, we only discuss three document types examples: conference review, conference paper, and article. In contrast, the other four document types (review, note, book, and book chapter) are discussed in other sections of this paper. An example of a conference review type article was editorialized by Pichappan et al. (2024) when reviewing the *"5th International Conference on Real-Time Intelligent Systems, RTIS 2023."* The substantial attendance at conferences reflects a growing interest in the field; however, the relatively limited number of journal publications suggests that the field remains in an early stage of development.

Furthermore, the type of conference paper Usra et al. (2021) sought to promote their idea entitled *"Swimming exercise model policy using straps as an aid for beginners,"* published in the Proceedings of the International Conference on Industrial Engineering and Operations Management Sao Paulo, Brazil, April 5 - 8, 2021. The author found that there was a significant improvement in the results of the three learning cycles that had been arranged, such as students applying the floating learning method with rope aids, the second cycle, they swam using a rope as an aid, and the third cycle, where they performed swimming movements freely without any assistance. Changes occurred in applying the swimming method, such as using a rope so that students who could not swim could finally swim.

Then, the type article written by Guo (2016) with the title *"Application of Virtual Reality Technology in Swimming Teaching"* was published in the *"International Journal of Emerging Technologies in Learning"*, 11 (11), pp. 9-14. The author argues that the swimming teaching system can solve the problem of perception-action separation, increase the ecological validity of the study, and is very promising for perception-action studies. A Student conducted a comparison analysis between

correct and incorrect swimming movements comparison, and the results showed that the virtual reality system solved the problem of monotonicity in actual swimming teaching.

In addition, one example of a type review was written by Wang et al. (2022) entitled "*Effects of blended learning in physical education among university students: A systematic review.*" The authors from Universiti Putra Malaysia discussed that blended learning (BL) models have attracted the attention of university lecturers and students worldwide in recent years. However, systematic reviews related to the effectiveness of BL in university physical education are still lacking. Therefore, this study aimed to evaluate the effect of BL on physical education among university students.

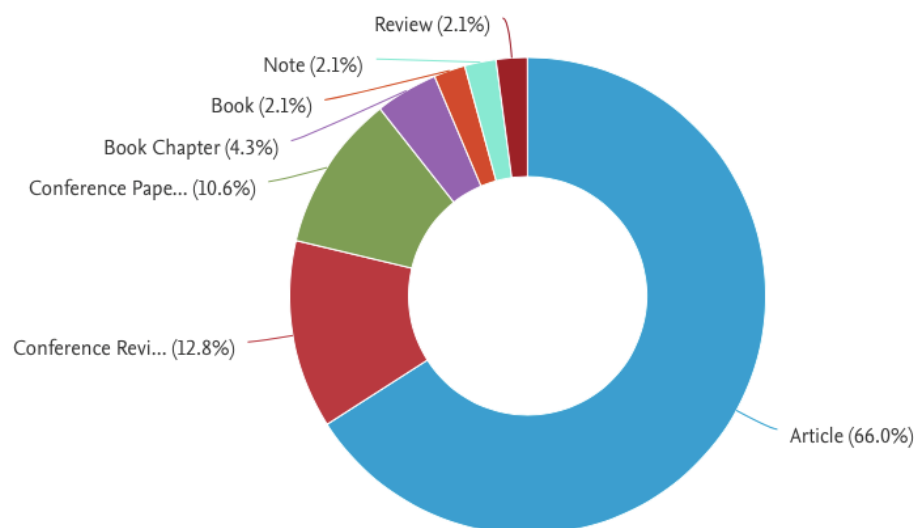


Figure 7. Document by type

Citation Trends

Over 22 years, the highest citation occurred in 2016, with 44 citations from 1 document. The highest citation (44 citations) was in an article written by Iserbyt et al. (2016) entitled "*The influence of content knowledge on teaching and learning in traditional and sport education contexts: An Exploratory Study*" published in *Physical Education and Sport Pedagogy*, 21 (5), pp. 539-556. Although Iserbyt et al. (2016) is among the most frequently cited works, its focus lies in general sports pedagogy. As such, the most cited literature predominantly addresses the broader context of physical education rather than swimming-specific instructional models. This highlights a clear gap and reinforces the need for targeted research on swimming learning models, which could serve as essential references for advancing research and practice in student swimming education.

Then the second place (27 citations) is in the article written by Whipp et al. (2014) entitled "*Differentiation in outcome-focused physical education: Pedagogical rhetoric and reality*," published by *Physical Education and Sport Pedagogy*, 19(4), pp. 370-382. The third place (26 citations) is the article written by Çakır et al. (2017) entitled "*Protective effect of low dose caffeine on psychological stress and cognitive function*," published by *Physiology and Behavior*, 168, pp. 1-10. Furthermore, in 2019 with a number of citations 23 from 1 document, there was an article written by Wang (2019) entitled "*Energy consumption in elementary and high schools in Taiwan*," published by the *Journal of Cleaner Production*, volume 227, pages 1107-1116, April 22, 2019. The fifth highest citation (16 citations) is in the book written by Penney et al. (2005) with the title "*Sport education in physical education: Research based practice*," published by Routledge.

If the reader tracks as a whole, then the top citation (44 citations) is in the article entitled "*The influence of content knowledge on teaching and learning in traditional and sport education contexts: An exploratory study*" written by Iserbyt et al. (2016). The article with the lowest top citations (16 citations) was tracked in the book entitled "*Sport education in physical education: Research based practice*," written by Penney et al. (2005). Meanwhile, out of 47 documents, 29 articles have not received citations (0). The sample article that has never been cited is entitled "*The effect of using visual aids on learning some swimming skills among hearing-impaired individuals by*," Abu Eid et al. (2023).

Table 1. Five top citations

No	Cites	Author (years)	Title	Publication identity
1	44	Iserbyt et al. (2016)	The influence of content knowledge on teaching and learning in traditional and sport education contexts: An exploratory study	Physical Education and Sport Pedagogy, 21(5), pp. 539–556
2	27	Whipp et al. (2014)	Differentiation in outcome-focused physical education: Pedagogical rhetoric and reality	Physical Education and Sport Pedagogy, 19(4), pp. 370–382
3	26	Çakır et al. (2017)	Protective effect of low dose caffeine on psychological stress and cognitive function	Physiology and Behavior, 168, pp. 1–10
4	23	Wang (2019)	Energy consumption in elementary and high schools in Taiwan	Journal of Cleaner Production, 227, pp. 1107–1116
5	16	Penney et al. (2005)	Sport education in physical education: Research based practice	Routledge

Table 2. Trend citation based on unit of analysis

Document	Sources	Authors	Organization	Countries
Iserbyt et al. (2016) (44 citation; 0 total link strength)	Physical Education and Sport Pedagogy (2 document; 71 citation; 0 total link strength)	Iserbyt et al. (2016) (1 document; 44 citation; 0 total link strength)	Kinesiology/ physical education teacher (1 document; 44 citation; 0 total link strength) Physical activity, sport and health research group (1 document; 44 citation; 0 total link strength)	United States (6 document; 55 citation; 0 total link strength)

Keyword Trends

Keyword trends are analyzed using the unit of analysis of all keywords with the full counting method, and the minimum number of occurrences of a keyword is 3, resulting in 19 that meet the threshold of 420. In selecting the number of terms, from 19 keywords with the most significant total link strength, 420 keywords will be selected. The results of the analysis found that the 19 selected items formed 3 clusters, 91 links, and 216 total link strengths (see Table 3). Furthermore, the 8 keywords with the highest occurrence are 1) *swimming* (12 occurrences with 40 total link strength), 2) *article* (8 occurrences with 47 total link strength), 3) *student* (7 occurrences with 19 total link strength), 4) *human* (5 occurrences with 25 total link strength), 5) *male* (5 occurrences with 35 total link strength), 6) *physical education* (5 occurrences with 11 total link strength), 7) *teaching* (5 occurrences with 23 total link strength), and 8) *adult* (4 occurrences with 26 total link strength).

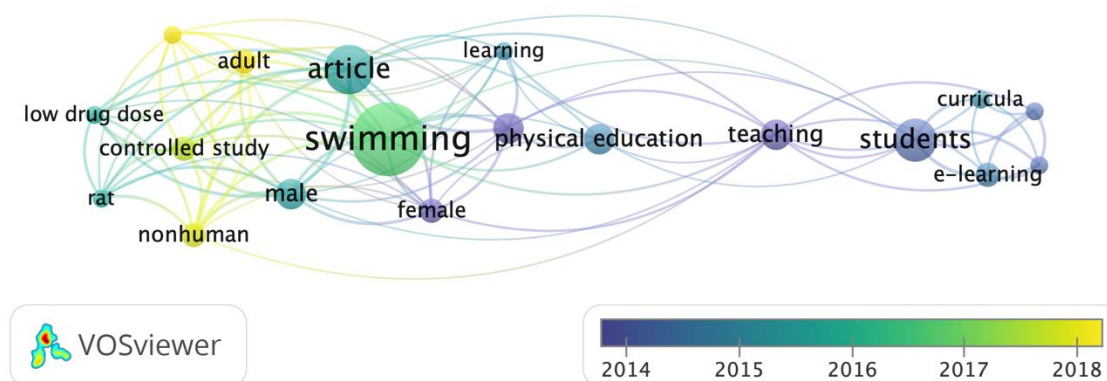


Figure 8. Network and overlay visualization of keywords trends

Table 3. Cluster of 19 items

Cluster	Colour	Items	Total
1	Red	Adult, article, cognition, controlled study, low drug dose, male, nonhuman, rat	8 items
2	Green	Curricula, e-learning, education computing, students, teaching, three dimensional computer graphics	6 items
3	Blue	Female, human, learning, physical education, swimming	5 item

In the choose threshold display, the minimum number of occurrences of terms used is 5, so it only forms 98 that meet the threshold of 2065 terms. Furthermore, from the 98 terms, the most relevant term will be selected in the chosen number of terms view, which is 59 (60% of the most relevant terms). The analysis found that the 59 selected terms formed 6 clusters, 547 links, and 6689 total link strength (see Table 4). Furthermore, the ten terms with the highest occurrences are 1) *education* (38 occurrences with 0.59 relevance), 2) *application* (21 occurrences with 0.91 relevance), 3) *rat* (20 occurrences with 0.66 relevance), 4) *teacher* (18 occurrences with 0.84 relevance), 5) *control group* (18 occurrences with 0.53 relevance), 6) *development* (17 occurrences with 0.64 relevance), 7) *class* (16 occurrences with 0.66 relevance), 8) *time* (16 occurrences with 0.38 relevance), 9) *problem* (15 occurrences with 0.94 relevance), and 10) *performance* (14 occurrences with 1.02 relevance). Meanwhile, out of 59 terms, the term included in the current study's occurrences is "*teaching model*" which is in 27th place with nine occurrences and a relevance of 1.24.

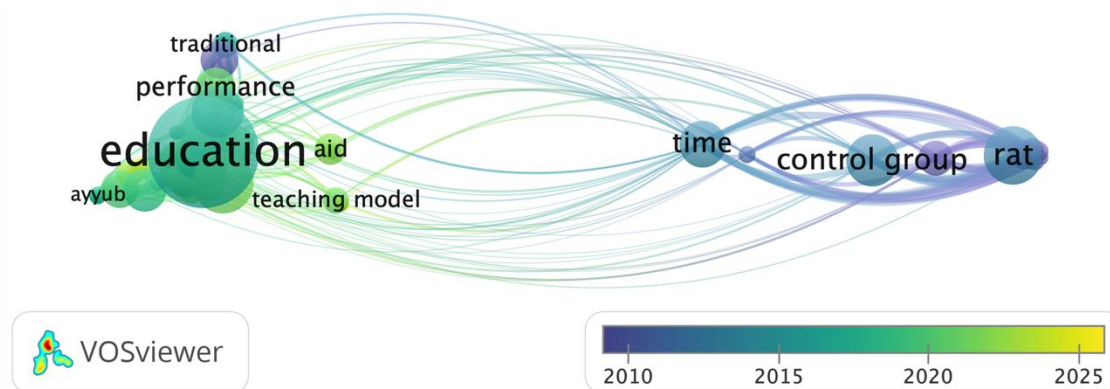


Figure 9. Network and overlay visualization of title and abstract trends

Despite visualizing more terms through titles and abstracts, keyword visualization is similar. Still, it turns out that the term “*teaching model*” does not have a network with swimming. The “*teaching model*” network was only formed with the terms “*application*,” “*outcome*,” “*education*,” “*interaction*,” “*teacher*,” “*time*,” and “*control group*.” In the VOSviewer visualization, both network and overlay (see Figure 9), the terms searched for SLM also have a lower label (item) load of the terms “*education*,” “*rat*,” “*time*,” “*sport education*,” and also “*teacher*.” In addition, as shown in Figures 8 and 9, the terms swimming and teaching models appear in separate clusters. This finding reinforces the existence of a gap between the development of swimming learning models and their implementation in educational practice. Thus, future investigations into SLM have the potential to support helping teachers streamline and optimize learning to maximize task performance and student learning outcomes.

Table 4. Cluster of 59 items

Cluster	Colour	Items	Total
1	Red	Age, aipl, application, case study, class, company, development, e module, education, endoscope, evidence, experience, form, implementation, instructor, interaction, interest, interview, iot, lesson, need, outcome, paper, pool, proceeding, project, surfing, teacher, team, and topic	30 items
2	Green	Change, control group, day, ketamine, ketamine group, latency, peripheral blood, platform, rat, time, and tnf	11 items
3	Blue	Performance, se group, session, sport education, term, traditional, and traditional ck	7 items
4	Yellow	Ayyub, case, catherine, employee, organization, and problem	6 items
5	Purple	Artificial intelligence, college, and teaching model	3 items
6	Light blue	Aid and rope	2 items

The tracking results of this study have confirmed that the development of learning models for students is still very open. This conclusion is based on the visualization results of keywords, and the term “*teaching model*” from the Scopus international publication database does not have a network with the term “*swimming*.” However, the label “*swimming*” is the highest in keyword tracking. This study has also filled the void of the previous study by Aristizabal et al. (2022). The bibliometric study only reported increased scientific document production in the swimming field from 2010 to 2020. We tried to complement it by providing new data on investigating publications on swimming learning models. In addition to the study of the investigation being emphasized, we also report the latest data up to 2023, complementing the previous study, which only ended in 2020.

Of the 47 article titles, abstracts, and keywords “*swimming AND learning AND model AND for AND students*”, the few studies that were confirmed to examine SLM were written by Wahyudi et al. (2024) in an article entitled “*The effect of a life skill-based learning model on improving students' basic ability to survive in water for 60 minutes through swimming*,” and an article entitled “*Application of virtual reality technology in swimming teaching*,” written by Guo (2016), as well as an article entitled “*Pedagogical competence analysis based on the TPACK model: Focus on VR-Based survival swimming instructors*,” written by Shin and Kim (2024). So far, a number of publications of bibliometric studies on SLM have not been conducted previously by several researchers from various countries, including island countries (such as Sweden and Norway and so on) and also countries that are prone to water natural disaster problems (including Japan, the Philippines, and so on).

Swimming skills are essential for students to help them maintain their safety in aquatic activities, whether they occur intentionally during recreation learning or natural disasters. Students must be trained to protect themselves from various risks and adjust to their safety in water. The World Health Organization even recommends that swimming skills, water safety, and rescue skills need to be taught to all school-age children (Petrass et al., 2021) because drowning has become a severe public health threat that has claimed the lives of 372.000 people each year worldwide (Roche et al., 2022). Students taught in formal swimming lessons can reduce the risk of drowning. For example, children aged 1-4 years can reduce the risk by 88% (with a risk reduction confidence interval ranging from 3% to 99%) (Brenner et al., 2009; McIntosh, 2009).

Swimming is a complex movement activity, so to ensure that the teacher's teaching activities can run effectively and efficiently, the teacher needs an appropriate learning model according to the learning objectives. A learning model is a conceptual framework that describes systematic procedures in organizing learning experiences to achieve goals (e.g., improving learning outcomes) and measuring student perspectives. The learning model ensures what activities teachers or students need to carry out, how the sequence of these activities is, and the specific tasks that students need to carry out can be explained well (Blegur, Ma'mun, et al., 2024; Ryan et al., 2022). In short, the learning model provides a way of teaching that guides the development of learning experiences and the identification of structures that support learning. The learning model shows the type of learning and outcomes that can be anticipated if used (Behar-Horenstein & Seabert, 2005).

The need for learning outcomes and skills in each learning greatly determines the learning model used. For this reason, Solissa et al. (2024) emphasize that teachers need to identify the goals and syntax

of students' learning experiences and correlate them with a selective learning model for achieving student performance and learning outcomes. For example, if learning to swim aims to improve aquatic competence and prevent students from drowning (Peden & Franklin, 2020; Stallman et al., 2008), then teachers must use a learning model that encourages students to think about the importance of swimming skills, be positive about various swimming learning experiences, and be skilled at using various parts of their body to be able to "control" themselves when in the water. So, students continuously participate in swimming learning activities not because of the "curriculum routine" of education but because of their essential needs to avoid health problems (including death due to drowning).

Therefore, we have concluded that future research on innovation of swimming learning models needs to be developed by considering comprehensive syntax and task performance to overcome the problems of students' interest in learning to swim (Sin & Hudayani, 2020), students' fear when learning to swim (Ostrowski et al., 2022; Peden & Franklin, 2020; Sukur et al., 2018) and students' boredom in swimming learning due to monotonous teacher teaching (Bielec & Saklak, 2013). Furthermore, although it is not included in the Scopus international index database, considering its usefulness, the following article can consider future innovation of swimming learning models, for example, the ISLAMT2E model (Instructing, Saving, Learning, Analysing, Measurement, Group Task, Individual Task, Evaluation), based on static swimming tools (Ginting et al., 2021), peer tutoring learning model (Abidin, 2021), CS 6 flash-based swimming learning model (Zulkifli et al., 2023), and the STAD learning model (Syahrudin et al., 2023).

CONCLUSION

Research on publication trends of student swimming learning models for 22 years found only 47 successfully published documents, with the most publications in 2023 with ten documents. The International Journal of Human Movement and Sport Science and Emerald Emerging Markets Case Studies are the highest sources that successfully published three documents during 2002-2024. Furthermore, the country that contributed the most to the publication of swimming learning models for students was China, with eight documents. The highest citation in 2016, with 44 citations, was in the article *"The influence of content knowledge on teaching and learning in traditional and sport education contexts: An exploratory study,"* written by Iserbyt et al. (2016) from the United States.

VOSviewer visualization proves that the keywords and term *"swimming learning model"* are proven to have a small item load, so they are less visualized in the VOSviewer output and lack networking. This study has proven that the results of the *swimming Learning model for student* inspection still have potential for future research. Therefore, future research should focus on developing swimming learning models that incorporate trauma-informed practices to support students with water anxiety, alongside gamification strategies to mitigate monotonous instruction. Such an approach aims to create a learning environment that is both enjoyable and ensures student safety and comfort in the water.

CONFLICT OF INTEREST

There are no conflicts of interest related to this research or the publication of this manuscript

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