

Mapping the intellectual and conceptual structure of physical education research: Direct citation analysis

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Abstract

Purpose: The aim of the study is to identify and explore the intellectual and conceptual structure of physical education research. It is focused around the following study questions: (1) What are the most influential publications within the research field? (2) What are the research fronts in physical education studies?

Material: As a result of the research sampling process, the 10,334 publications indexed in the Scopus database were selected by the title search for the phrase 'physical education'. Citation analysis, one of science mapping methods, was employed to conduct the analysis. The study process and the visualization of its findings were supported by the VOSviewer software. In the process of citation analysis, we used the following weight attributes: (1) custom weight attributes: the number of citations received by a document and the normalized of citations for a document, and (2) standard weight attributes: the number of citation links.

Results: Firstly, the most prominent references have been pointed out and discussed. The study of the effects of the SPARK physical education program in regard to physical activity of elementary school pupils by Sallis et al. (1997) is found to be the most cited publication in the physical education research field. The systematic literature review and meta-analysis of research on application of self-determination theory in the physical education context by Vasconellos et al. (2020) is recognized as the publication of the highest value of the normalized number of citations. The application of self-determination theory of motivation in physical education is the topic attracting a lot of attention of the top cited publications in the field. The prominent and central position of these references is confirmed by the analysis of citation links. Secondly, the following research fronts in physical education studies have been identified: (1) motivation in physical education, (2) physical education programmes, (3) development of physical education, (4) self-determination in physical education, (5) physical education and students' academic achievement, (6) support of physical activity autonomy, (7) gender and physical education, and (8) long-term effects of physical education. Combining the research fronts identified with co-word analysis and direct citation analysis, the two-dimensional matrix mapping the conceptual structure of the physical education research field has been developed. The matrix categorizes publications according to their themes and the age of students / the levels of education, which are the object of the analysed studies.

Conclusions: The study contributes mainly to development of theory through mapping the scientific output within the physical education research field. Identification of core references provides valuable information for the scholars cultivating the field about the most recognized classical works receiving the highest number of citations and 'emerging stars' of the highest normalized number of citations. Such information is crucial for any theoretical reviews regarding the issues of physical education. Discovering research fronts points out the themes of the highest prominence and may be an indication for searching prospective research topics by authors. Developing the matrix to be used for mapping the conceptual structure of the research field is another contribution of the study.

Keywords: physical education, bibliometrics, science mapping, direct citation analysis.

Introduction

Discussing scenarios of physical education development, Kirk (2009) [1] "argues that multi-activity, sport based forms of physical education have been dominant in schools since the mid-twentieth century and that they have been highly resistant to change. The practice of physical education has focused on the transmission of de-contextualised sport-techniques to large classes of children who possess a range of interests and abilities, where learning rarely moves beyond introductory levels. Meanwhile, the academicization of physical education teacher education since the 1970s has left teachers less well prepared to teach this programme than they were

previously, suggesting that the futures of school physical education and physical education teacher education are intertwined". Multidimensionality of physical education studies and practice, and its importance for contemporary man encourages the ranks of researchers to cultivate the field, which contributes to its development. Nevertheless, in spite of the dynamic development of research in physical education, as observed by Tomanek and Lis (2020) [2], the research field has not been mapped from the bibliometric perspective, so far. There are very few studies covering the bibliometric analysis of the whole research field. What is more, some of them are limited to the time span covered by the analysis, e.g. the study by Fan and Gan (2010) [3], or they employ only simple bibliometric descriptive methodologies e.g. the research

profiling study by Hinojo-Lucena et al. (2019) [4]. Taking into account these observations we assume that the identified gap in the body of knowledge remains unfilled and there is need for more bibliometric studies in the research field.

Thus, the aim of the study is to identify and explore the intellectual and conceptual structure in physical education research. It is focused around the following study questions: (1) What are the most influential publications within the research field? (2) What are the research fronts in physical education studies? The study employs the method of citation analysis for mapping the scientific output within the physical education research field. The remainder of the paper consists of three main chapters. Firstly, the research sampling process and the method of study are explained. Secondly, the results of bibliometric analysis are presented and visualized, paying attention to core references and research fronts. Thirdly, the research findings are discussed and interpretations are provided.

Material and Methods

Data Sources and Research Sample

We selected Scopus as a source of bibliometric data for

analysis. Besides Web of Science, Scopus is recognized as one of two leading, worldwide databases abstracting and indexing high-quality research publications [5, 6]. In the procedure of research sampling, we searched for publications including phrase ‘physical education’ in their titles, regardless of a subject area or a date of publication. We purposely, replicated data sampling criteria used by Tomanek and Lis (2020) [2] in order to: (1) observe any changes in the field taking place in 2020, and (2) establish the conditions for comparing and contrasting research fronts identified by Tomanek and Lis (2020) [2] with the use of co-word analysis methodology [7] and our study based on direct citation analysis.

As of 15 December 2020, we retrieved 10,334 publications comprising the research sample. The majority of them are journal articles (8,704 items; 84.2%), written in English (8,115; 78.5%). The retrieved publications are distributed over twenty six non-exclusive subject areas, among which the most populated include: Social Sciences (6,150 items), Medicine (4,810), and Health Professions (4,365). The detailed characteristics of the research sample in regard to the document types, publication languages and subject areas are presented in Figure 1.

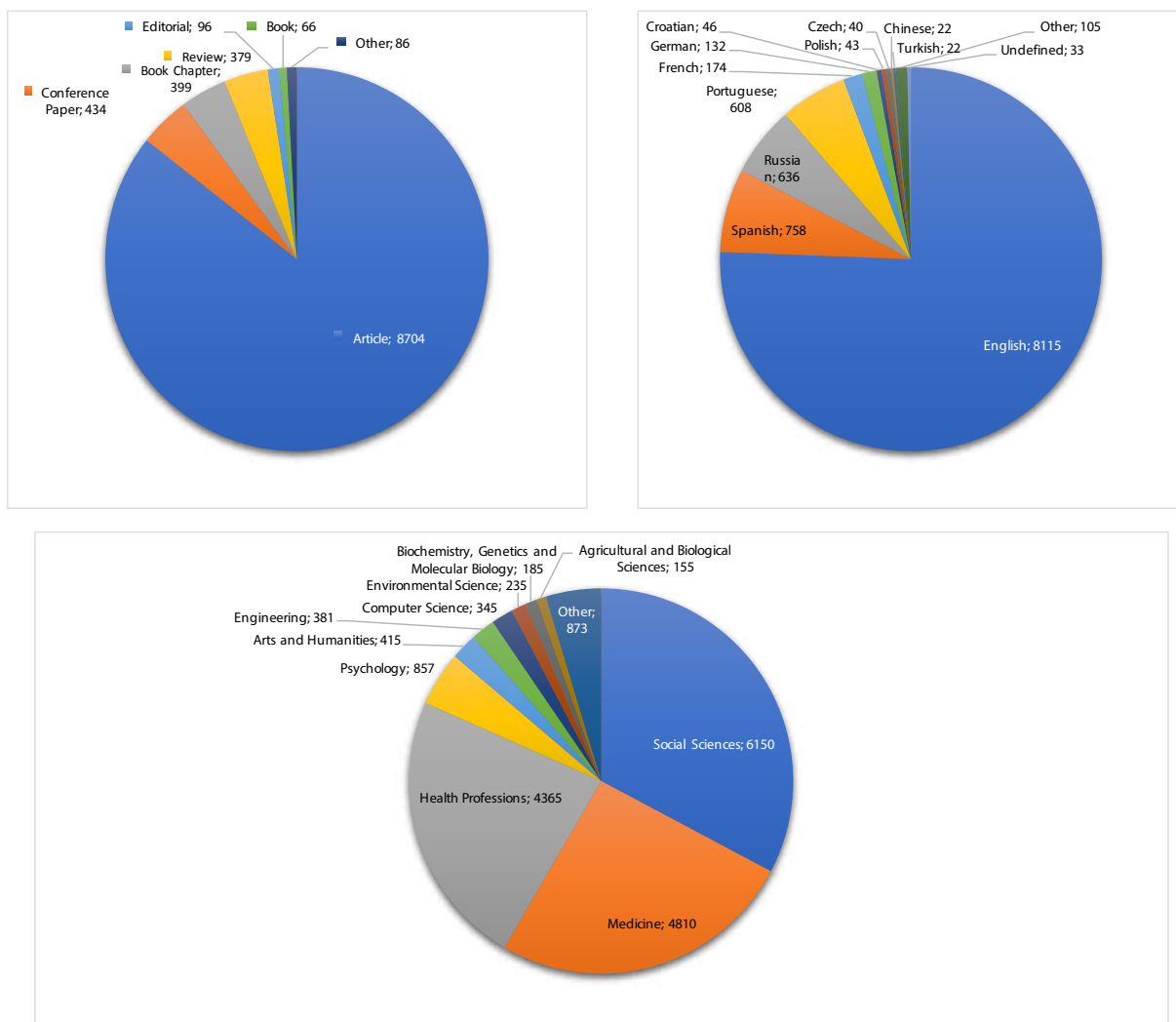


Figure 1. Characteristics of the research sample (by document type, language of publication, subject area): Source: Own study based on data retrieved from Scopus (15 December 2020).

Comparing and contrasting the structure of the research sample with the characteristics of the sample retrieved in January 2020 by Tomanek and Lis (2020) [2] indicates no significant changes in regard to the type and language of publications, and represented subject areas.

Method of Study

Citation-based methods, which refer to relationships among the publications, are an important component of science mapping methodology. Citation based approaches include: direct citation (intercitation) analysis, bibliographic coupling and co-citation analysis [8]. In our study, we employed direct citation analysis [9], which is used to evaluate the influence of references on the research field by calculating the number of citations those references have received. In spite of its natural bias towards earlier publications, which have more chances to be cited than those recent ones, the method is recognized as an useful approach to identify the most influential works in the field [8]. In regard to discovering research fronts, although direct citation analysis shows lower accuracy in mapping science while comparing against bibliographic coupling and co-citation analysis [10], it is found to be more effective in discovering emerging research fronts [11]. Thus, considering all the strengths and weaknesses of the method, we decided to use direct citation analysis for the purpose of the study. The processes of analysis and visualization of findings were supported with VOSviewer software [12, 13]. The association strength normalization method was used for analysis. Default values of layout and clustering parameters, with the exception of the minimum cluster size, were employed. The minimum number of items within a cluster was set as 100 for network analysis of the whole sample and 5 for network analysis of core references (meeting the threshold of 100 citations).

In the process of citation analysis, we used the following weight attributes: (1) custom weight attributes: the number of citations received by a document and the normalized number of citations for a document, and (2) standard weight attributes: the number of citation links.

The number of received citations manifests the interest of other scholars in a publication and its prominence in the field. In order to mitigate the natural bias of citation analysis toward older publications, we included into analysis the attribute of the normalized number of citations. “The normalized number of citations of a document equals the number of citations of the document divided by the average number of citations of all documents published in the same year and included in the data that is provided to VOSviewer. The normalization corrects for the fact that older documents have had more time to receive citations than more recent documents” [13, p. 37]. We assessed relatedness among the publications within the sample with the number of citation links. “A citation link is a link between two items where one item cites the other. Citation links are treated as undirect by VOSviewer. Hence, no distinction is made between a citation from item A to item B and a citation in the opposite direction” [13, p. 26].

Results

Core references

Among 10,334 publications included in the research sample, there are 6,452 items which were cited at least once. The threshold of 10 citations was attained by 2,189 publications, the threshold of 100 citations – by 118 publications. In the first step of analysis, we identified core references taking into account the criteria of the number of received citations, normalized citations and the number of citation links. As some of the analysed 10,334 publications were not connected to each other, we limited the analysis to the largest set of connect items consisting of 5,818 items. The catalogue of identified core references is provided in Table 1, and graphical visualization of citation analysis respectively in Figures 2 – 4.

The study of the effects of the SPARK physical education program in regard to physical activity of elementary school pupils by Sallis et al. (1997) [14] is found to be the most cited publication in the research

Table 1. Core references in physical education research

Citations		Normalized Citations		Citation Links	
Reference	N	Reference	N	Reference	N
Sallis et al. (1997) [14]	592	Vasconellos et al. (2020) [15]	39.37	Ntoumanis (2001) [16]	204
Standage et al. (2005) [17]	486	D’elia (2019) [18]	28.19	Standage et al. (2005) [17]	184
Standage et al. (2003) [19]	478	Raspberry et al. (2011) [20]	26.55	Standage et al. (2003) [19]	180
Ntoumanis (2001) [16]	474	Sallis et al. (1997) [14]	20.48	Ntoumanis (2005) [21]	180
Ntoumanis (2005) [21]	397	Sallis (1991) [22]	19.95	Vasconellos et al. (2020) [15]	175
Sallis (1991) [22]	365	Henry (1978) [23]	18.33	Goudas et al. (1994) [24]	167
Trudeau and Shephard (2008) [25]	359	Corder (1966) [26]	17.91	Sallis (1991) [22]	164
Kirk (2009) [1]	350	Staiano and Calvert (2011) [27]	17.58	Sallis et al. (1997) [14]	149
Bailey (2006) [28]	338	Wilson et al. (2020) [29]	16.87	Bailey et al. (2009) [30]	137
Coe et al. (2006) [31]	333	Kirk (2013) [32]	15.81	Sallis et al. (2012) [33]	130

Source: Own study based on data retrieved from Scopus and analysed with VOSviewer (15 December 2020).

field. The followers are the works dealing with self-determination theory in physical education written by: Standage et al. (2005) [17], Standage et al. (2003) [19], Ntoumanis (2001) [16], and Ntoumanis (2005) [21]. Standage et al. (2005) [17] test self-determination theory based motivation in physical education in the context of the British secondary school. In their earlier study, Standage et al. (2003) [19] investigate the motivation of students to actively participate in physical education activities with the use of a model based on the assumptions of self-determination theory and achievement goal theory. The studies by Ntoumanis focused on “[a] self-determination approach to the understanding of motivation in physical education” [16] and “participation in optional school physical education using a self-determination theory framework” [21] are additional examples of research interest in the issues related to self-determination theory of human motivation in the context of physical education. The outcomes of physical activity for students’ health and social behaviours as well as their school performance constitute the second stream of interest of the most cited publications. Sallis (1991) [22] investigates the role of physical activity for children’s health. Trudeau and Shephard (2008) [25] conduct a systematic literature review aimed at investigating the impact of allocating additional times for physical education, physical activity and school sports on academic performance. Coe et al. (2006) [31] analyse the “[e]ffect of physical education and activity levels on academic achievement on children”. Bailey (2006) explores the benefits from physical education and sport for students and educational systems. Last but not least, Kirk (2009) [1] develops scenarios of the future of physical education.

As already mentioned, in order to mitigate the bias of citation analysis to older publication, which have more opportunities to receive citations, we used for analysis the attribute of the normalized number of citations. The findings make a mixture of some very recent documents (2019-2020), highly cited publications from the 1990s and the 2010s and some older items dated as of the 1960s and the 1970s. Among the latest works, Vasconellos et al. (2020) [15] conduct the systematic literature review and meta-analysis of research on application of self-determination theory in the physical education context. D’elia (2019) [18] analyse and develop recommendations for curricula of the courses for physical education teachers from Italian primary schools. Wilson et al. (2020) [29] discuss the case of the U.S. mandate on “the least restrictive environment in physical educations”. The second category includes the already mentioned works by Sallis (1991) [22] and Sallis et al. (1997), as well as the studies by Rasberry et al. (2011) [20], Staiano and Calvert (2011) [27], and Kirk (2013) [32]. Rasberry et al. (2011) [20] revise the scientific output investigating the relationship between physical activity and academic performance. Staiano and Calvert (2011) [27] explore the benefits from digital games combined with physical activity, the so-called ‘exergames’. Kirk (2013) [32] analyses “[e]ducational value and models-based practice

in physical education”. It is interesting that some older publications such as the treatise on “[t]he academic discipline of physical education” by Henry (1978) [23] and the study of physical education effects on development of “educable mentally retarded boys” by Corder (1966) [26] are found among the publications of the highest value of the normalized number of citations.

Taking into account the number of citation links within the research sample, the Ntoumanis’ study of “[a] self-determination approach to the understanding of motivation in physical education” [16] is identified as the top achiever. The followers are the already discussed publications focused on self-determination theory of motivation such as: Standage et al. (2005) [17], Standage et al. (2003) [19], Ntoumanis (2005) [21], and Vasconellos et al. (2020) [15]. Goudas et al. (1994) [24] “examined the relationships of perceived autonomy, perceived competence and goal orientations with intrinsic interests across two PE activities”. Bailey et al. (2009) [30] revise the benefits from physical education and sport for physical, social, affective and cognitive domains. The catalogue of the most linked publications within the sample is completed by the aforementioned works by: Sallis et al. (1997) [14], Sallis (1991) [22], and the article revisiting the discussion on the role of physical education in public health by Sallis et al. (2012) [33].

Research fronts

In the second step of analysis, we focused on identifying research fronts within the field. We employed the network visualization function of VOSviewer (with default parameters) to display the groupings of publications within the field (Figure 5). 5,818 items taken for analysis are distributed over 26 clusters numbering from 103 items (the smallest one) to 459 items (the largest one).

In order to analyse thoroughly the research fronts in the field, we selected the core references with a minimum number of 100 citations per document. For each of 118 publications, the number of citation links was calculated. As some of the identified items were not connected to each other, the largest set consisting of 103 connected items was taken for further network analysis in order to map the interconnected clusters used for discovering research fronts (Figure 6). The structure of the identified clusters is detailed in Table 2.

Cluster 1, labelled as ‘motivation in physical education’, includes publications mainly from education and psychology journals. It shows strong links with the clusters dealing with the issues of self-determination (Cluster 4) and autonomy (Cluster 6). It results from the assumptions of self-determination theory, which state that in order to motivate students to actively participate in physical education, it is critical to support meeting their innate, psychological needs in regard to autonomy, competence and relationships [52]. The most cited publication in the cluster, authored by Standage et al. (2005) [17], studies the model of motivation based on self-determination theory and indicates that “students who perceived a need-supporting environment

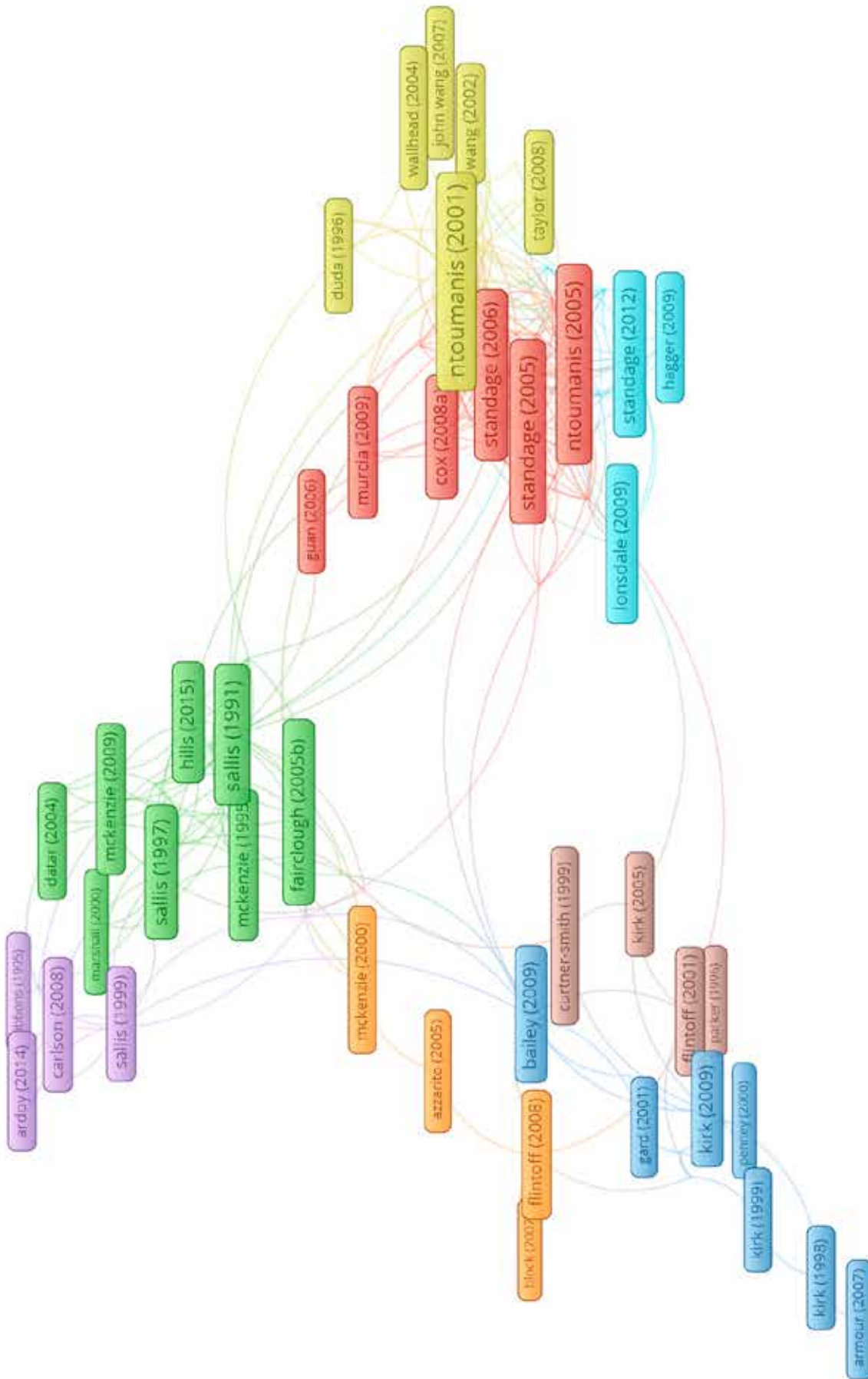


Figure 6. Direct citation analysis of core references in physical education research (network visualization, weights – links): Source: Own study based on data retrieved from Scopus and analysed with VOSviewer (15 December 2020).

experienced greater levels of need satisfaction” [17, p. 411.]. In an earlier study, Standage et al. (2003) [19] focus on predicting students’ intentions to take part in physical education activities with the use of constructs of achievement goal theory and self-determination theory. Numerous publications in Cluster 1 employ the technique of structural equation modelling (SEM). The example is the study by Haerens et al. (2015) [42], who “examined the mediating role of students’ experiences of need satisfaction and need frustration in associations between perceived teaching style and students’ motivation and oppositional defiance in the context of physical education”

[42, p. 26].

Cluster 2 is focused on ‘physical education programmes’. Sallis et al. (1997) [14], the most cited reference within the sample, provide the assessment of the health promoting physical education programme aimed at increasing physical activity of students during both in-school physical education classes and outside of the school. According to the authors, combining physical education and health education may result in more intensive physical activity during the schooling period and after. The emphasis on the advantages of matching physical education with health programmes is observed

Table 2. Clusters of core references in physical education research

Cluster number / label / colour / number of items	References
Cluster 1 / ‘motivation in physical education’ / red / N=22	Boiche et al. (2008) [34]; Cheon et al. (2012) [35]; Cox et al. (2008) [36]; Cox and Williams (2008) [37]; Ferrer-Caja and Weiss (2000) [38]; Guan et al. (2006) [39]; Haerens et al. (2010) [40]; Haerens et al. (2013) [41]; Haerens et al. (2015) [42]; Mouratidis et al. (2008) [43]; Murcia et al. (2009) [44]; Ntoumanis (2002) [45]; Ntoumanis et al. (2004) [46]; Ntoumanis (2005) [21]; Ntoumanis and Standage (2009) [47]; Standage et al. (2003) [19]; Standage et al. (2005) [17]; Standage et al. (2006) [48]; Taylor and Ntoumanis (2007) [49]; Taylor et al. (2010) [50]; Tessier et al. (2010) [51]; Van den Berghe (2010) [52]
Cluster 2 / ‘physical education programmes’ / green / N=21	Belsky et al. (2003) [53]; Burgeson et al. (2001) [54]; Cawley et al. (2007) [55]; Datar and Sturm (2004) [56]; Fairclough and Stratton (2005) [57]; Hills et al. (2015) [58]; Lee et al. (2007) [59]; Lonsdale et al. (2013) [60]; Marshall and Hardman (2000) [61]; McKenzie et al. (1995) [62]; McKenzie et al. (1996) [63]; McKenzie et al. (2004) [64]; McKenzie and Lounsbery (2009) [65]; Morgan and Hansen (2008) [66]; Nettlefold et al. (2011) [67]; Sallis (1991) [22]; Sallis et al. (1993) [68]; Sallis et al. (1997) [14]; Sallis et al. (2012) [33]; Trudeau et al. (1999) [69]; Van Beurden et al. (2003) [70]
Cluster 3 / ‘development of physical education’ / blue / N=15	Armour and Yelling (2004) [71]; Armour and Yelling (2007) [72]; Bailey (2005) [73]; Bailey et al. (2009) [30]; Gard and Wright (2001) [74]; Gorely et al. (2003) [75]; Kirk and Colquhoun (1989) [76]; Kirk and MacDonald (1998) [77]; Kirk (1999) [78]; Kirk (2006) [79]; Kirk (2009) [1]; Kirk (2013) [32]; Light (2008) [80]; Penney and Chandler (2000) [81]; Siedentop (2002) [82]
Cluster 4/ ‘self-determination’ in physical education’ / yellow / N=15	Digelidis et al. (2003) [83]; Duda (1996) [84]; Goudas et al. (1994) [24]; Goudas and Biddle (1994) [85]; Ntoumanis (2001) [16]; Papaioannou (1994) [86]; Papaioannou (2004) [87]; Solmon (1996) [88]; Standage and Treasure (2002) [89]; Standage et al. (2003) [90]; Taylor et al. (2008) [91]; Treasure and Roberts (1995) [92]; Wallhead and Ntoumanis (2004) [93]; Wang et al. (2002) [94]; Wang et al. (2007) [95]
Cluster 5/ ‘physical education and students’ academic achievement’ / violet / N=9	Ardoy et al. (2014) [96]; Bailey (2006) [28]; Carlson et al. (2008) [97]; Coe et al. (2006) [31]; Fairclough and Stratton (2005) [98]; Gibbons et al. (1995) [99]; Raspberry et al. (2011) [20]; Sallis et al. (1999) [100]; Trudeau and Shephard (2008) [25]
Cluster 6/ ‘support of physical activity autonomy’ / light blue / N=7	Chatzisarantis et al. (2003) [101]; Hagger et al. (2003) [102]; Hagger et al. (2005) [103]; Hagger et al. (2009) [104]; Lim and Wang (2009) [105]; Lonsdale et al. (2009) [106]; Standage et al. (2012) [107]
Cluster 7 / ‘gender and physical education’ / orange / N=7	Azzarito and Solomon (2005) [108]; Block and Obrusnikova (2007) [109]; Cockburn and Clarke (2002) [110]; Flintoff et al. (2008) [111]; Garrett (2004) [112]; Goodwin and Watkinson (2000) [113]; McKenzie et al. (2000) [114]
Cluster 8/ ‘long term effects of physical education’ / brown / N=7	Curtner-Smith (1999) [115]; Curtner-Smith (2001) [116]; Enright and O’Sullivan (2010) [117]; Flinton and Scraton (2001) [118]; Kirk (2005) [119]; McKenzie et al. (1997) [120]; Parker (1996) [121]

Source: Own study based on data retrieved from Scopus and analysed with VOSviewer (15 December 2020).

as well by Sallis (1991) [22], who claims that public health subject matter experts should be invited to design and assess school physical education programmes. Lee et al. (2007) [59], who analysed the reports of the American Centers for Disease Control and Prevention conducting the studies of school health policies and programs, notice that a significant part of schools were not conducting everyday physical education classes or released students from taking part in these classes. Another problem was associated with the career development paths of physical education teachers. Some of the states provided training programmes, which mismatched with the teachers' needs. In regard to education programmes, Morgan and Hansen (2008) [66] identify the barriers to teaching physical education programmes. What is interesting, institutional barriers and the factors out of teachers' control are recognized as the most thorny issues resulting in shortening physical education classes or poor quality of the classes.

Cluster 3, labelled as 'development of physical education', is centred around future directions of development of physical education and physical education teachers. Kirk (2009) [1] asks a rhetoric but fundamental question "Can we imagine a future in which physical education in schools no longer exists?". This question becomes particularly important nowadays, during the COVID-19 pandemic and on-line distance learning. Moreover, Kirk (2009) [1] highlights the relationship between education of future physical education teachers and trainers, and quality of physical education classes at schools. In this context, a forced shift to distance learning in physical education teachers' programmes and lack of internships at schools, due to the pandemic, may result in a lower level of knowledge, skills and social competencies of future physical education teachers. Thus, professional development of physical education teachers is the issue of paramount importance. Among studied publications within Cluster 3, Armour and Yelling (2004) [71] review the theory and research in the field of continuing professional development (CPD), and provide recommendations for developing a more effective model of professional development dedicated to physical education teachers (PE-CPD).

Cluster 4, labelled as 'self-determination in physical education', includes publications, which employ self-determination theory in the physical education context. The cluster shows spatial proximity and strong relatedness with Cluster 1 ('motivation in physical education') and Cluster 6 ('support of physical activity autonomy'). Referring to the work by Ames (1992) [122] dealing with the motivational climate within a classroom, Papaioannou (1994) [86] develops a questionnaire to measure the students' perception of their achievement orientation in physical education. Ntoumanis (2001) [16] concentrates on testing motivational processes among teenagers. The study takes into account social aspects, psychological mediators, various types of motivation and consequences. Goudas et al. (1994) [24] investigate "the relationships of perceived autonomy, perceived competence and

goal orientations with intrinsic interest across two PE activities" [24, p. 453]. Taylor et al. (2008) [91] examine how motivational strategies employed by physical education teachers can influence self-determination of their students. This study refers as well to the level of fulfilment of teachers' psychological needs and notices that "factors that influence teacher motivation may also indirectly affect their motivational strategies toward students" [91, p. 75].

Cluster 5, labelled as 'physical education and students' academic achievement', focuses on discussing positive outcomes of physical activity of children. The studied publications point out two main benefits of physical education related to improvements in health condition and academic achievement. Effectiveness of physical activity influence on achieving health objectives is explained by Fairclough and Stratton (2005) [98]. The benefits from physical education and sport are also discussed by Bailey (2006) [28], who highlights that positive effects of physical education are strongly mediated by relationships (engagement) between students and teachers, trainers and parents in addition to participation in physical activity. The influence of physical education and physical activity on academic achievement is studied by Trudeau and Shephard (2008) [25], whose article is the most cited reference within the cluster. They point out that physical activity shows positive relationship with academic achievement but physical fitness is not directly related with students' grades. Coe et al. (2006) [31] investigate students' engagement in physical education classes and grades they receive. Their study of 214 participants shows that students of 'vigorous physical activity' received better grades. What is interesting, they notice that "[m]oderate physical activity did not affect grades" [31, p. 1515]. Carlson et al. (2008) [97] researched more than 5,300 participants to test whether there are any relationships between academic achievement and physical education classes. They point out that more participation in physical education may contribute to better grades in mathematics and reading. What is worth mentioning, "a small but significant benefit" was noticed only among girls [97, p. 721].

Cluster 6, labelled as 'support of physical activity autonomy', concentrates on promoting physical activity in leisure time. This aspect is mainly realized in the psychological context, which is also highlighted by the leading themes of the journals publishing references included in the cluster. Hagger et al. (2003) [102] notice positive effects of the "trans-contextual model indicating that perceived autonomy support in an educational context influences motivation in a leisure-time context" [102, p. 784]. In their earlier study, Hagger et al. (2005) [103] examine "replicability and cross-cultural invariance of a trans-contextual model of motivation", which assumes that "perceived autonomy support [...] in physical education [...] predicts autonomous motivation, intentions, and behaviour in a leisure time [...] physical activity context" [103, p. 376]. An interesting innovation among research collected in Cluster 6 is the employment of pedometers

as a supplement of traditional questionnaire surveys. For instance, in the study conducted by Standage et al. (2012) [107], almost 500 students were using pedometers for four days to measure their physical activity in leisure-time.

Cluster 7, labelled as ‘gender and physical education’, explores the issues related to gender differentiation in physical activity. Garrett (2004) [112] makes an attempt to explain why girls give up physical activity in various stages of their lives and they consider physical education classes as a ‘problem’. An interesting assumption is made by Azzarito and Solomon (2005) [108], who claim it is physical education programme rather gender, race and social class standing behind decrease in physical activity among the youth. They recommend that “schooling should carry the responsibility of educating children to adopt and maintain a physically active lifestyle” [108, p. 25]. Cockburn and Clarke (2002) [110] point out the contrast between “the polarized images of ‘tomboy’ and ‘girlie’” among girls practising sports, which forces them to “creating ‘double identities’ and living ‘split lives’” [110, p. 651].

Cluster 8, labelled as ‘long-term effects of physical education’, is focused on analysis of the learning outcomes of physical education programmes in the long-term perspective. McKenzie et al. (1997) [120] conducted 4-year studies investigating how various groups of teachers influence quantity and quality of classes. Curtner-Smith (1999) [115] analyses the differences in interpretations of the National Curriculum Physical Education (NCPE) by British teachers of physical education in regard to their experience, gender, age and the level of physical activity. What is interesting, as indicated by Kirk (2005) [119], the newly implemented PESSCLS strategy promoting the life-long physical activity was found to be ineffective in spite of significant financial resources spent on it. The cluster includes as well the studies of relationships between educating teachers in higher education institutions and prospective ways of teaching physical education in primary schools [116]. The study by Enright and O’Sullivan (2010) [117] goes beyond investing the impacts of governmental regulations or training of future physical education teachers and it focuses on involving students in decisions regarding the content of physical education classes. As observed by the authors, such practices increase significantly students’ engagement and willingness to maintain physical activity.

Discussion

The results of the thematic mapping of the physical education research field, completed with the use of direct citation analysis, may be compared and contrasted with the study by Tomanek and Lis (2020) [2], which identifies leading thematic areas and emerging topics through co-occurrence analysis of high-frequency keywords (an example of co-word analysis). In order to optimise the conditions for the comparative analysis of research fronts, firstly, we purposely replicated data sampling criteria used in their study by Tomanek and Lis (2020) [2], and secondly, we employed the same software (VOSviewer)

to support data analysis and findings visualisation.

Thematic clusters identified with the use of co-word analysis focus on such issues as: “(1) ‘physical education didactics’, (2) ‘physical activity of school pupils’, (3) ‘physical education of adolescents’, (4) ‘human motor competence’, (5) ‘physical activity of adults’” [2]. At first sight, they seem to be very different from the findings from this study employing the method of direct citation analysis. For instance, in the current study, there is no categorization of clusters in regard to the age of participants of physical education as it was in the co-word analysis (e.g. school pupils, adolescents, adults). Nevertheless, a deeper analysis reveals that the topics discussed by publications comprising Cluster 2 (‘physical education programmes’) are close to those included in Cluster 1 (‘physical education didactics’) in the study by Tomanek and Lis (2020) [2]. Moreover, combining these two studies together, the two-dimensional matrix mapping the conceptual structure of the physical education research field may be developed (Figure 7).

In Figure 7, the vertical axis reflects the age groups recognized as units of analysis in the study by Tomanek and Lis (2020) [2], while the horizontal axis presents the variety of thematic areas discovered in our study through direct citation analysis i.e.: (1) ‘motivation in physical education’, (2) ‘physical education programmes’, (3) ‘development of physical education’, (4) ‘self-determination in physical education’, (5) ‘physical education and students’ academic achievement’, (6) ‘support of physical activity autonomy’, (7) ‘gender and physical education’, and (8) ‘long-term effects of physical education’. Combining the two aforementioned dimensions, the matrix may be useful for mapping the literature output in the physical education research field. For instance, the article by Ntoumanis (2001) [16] may be categorized within the thematic cluster dealing with self-determination theory in physical education (in the horizontal dimension) and simultaneously in the field corresponding to studies of adolescents (in the vertical dimension) (cf. Figure 7). Referring to the emerging topics, identified by Tomanek and Lis (2020), which include such issues as: “(1) ‘physical education teachers and their training/education’, (2) ‘physical education in the tertiary education context’, (3) ‘physical education in the secondary education context’” [2], replacing or supplementing age categories with the corresponding levels of education may be recommended.

Conclusions

In response to the first research question, we have recognized the most influential publications within the research field. The study of the effects of the SPARK physical education program in regard to physical activity of elementary school pupils by Sallis et al. (1997) is found to be the most cited publication in the physical education research field. The systematic literature review and meta-analysis of research on application of self-determination theory in the physical education context by Vasconellos et al. (2020) is recognized as the publication of the

adults / tertiary education								
adolescents/ secondary education				e.g. Ntoumanis (2001) [16]				
children / primary education								
	1	2	3	4	5	6	7	8

Note: (1) motivation in physical education, (2) physical education programmes, (3) development of physical education, (4) self-determination in physical education, (5) physical education and students’ academic achievement, (6) support of physical activity autonomy, (7) gender and physical education, and (8) long-term effects of physical education.

Figure 7. Two dimensional matrix mapping the conceptual structure of the physical education research field: Source: Own study based on combination of findings from co-word analysis [2] and direct citation analysis

highest value of the normalized number of citations. The application of self-determination theory of motivation in physical education is the topic attracting a lot of attention of the top cited publications in the field. The prominent and central position of these references is confirmed by the analysis of citation links. In response to the second research question, we have identified the research fronts in physical education studies, which include: (1) ‘motivation in physical education’, (2) ‘physical education programmes’, (3) ‘development of physical education’, (4) ‘self-determination in physical education’, (5) ‘physical education and students’ academic achievement’, (6) ‘support of physical activity autonomy’, (7) ‘gender and physical education’, and (8) ‘long-term effects of physical education’.

The study contributes mainly to development of theory through mapping the scientific output within the physical education research field. Identification of core references provides valuable information for the scholars cultivating the field about the most recognized classical works receiving the highest number of citations and ‘emerging stars’ of the highest normalized number of citations. Such information is crucial for any theoretical reviews regarding the issues of physical education. Discovering research fronts points out the themes of the highest prominence and may be an indication for searching prospective research topics by authors. It is worth highlighting that the study triangulates, through direct citation methodology, the findings from the co-word analysis conducted by Tomanek and Lis (2020) [2]. As already mentioned, the physical education research field still lacks thorough mapping with the use of bibliometric methods. Thus, the study seems to be a unique and highly valuable contribution to the theory development in the field. Development of the matrix to be used for mapping the conceptual structure of the research field is another contribution of the study.

Appreciating quality and added value of the study,

its limitations should be made explicit. Firstly, only one research method i.e. direct citation analysis was employed. As far as the conceptual structure of the field is concerned, identified research fronts have been compared and contrasted with findings of earlier publications [2]. Nevertheless, mapping of the intellectual structure has not been triangulated with other methods. Secondly, inherent weaknesses of citation analysis should be taken into account such as: unknown reasons for citing a documents, self-citations etc. [8,9]. Thirdly, Scopus was the only source of bibliometric data used in the research sampling process. Thus, the following lines of effort for further studies may be recommended: (1) employing other citations methods e.g. co-citation analysis [123] and bibliographic coupling [124] to triangulate the findings related to the intellectual networks and research fronts in the field, (2) replicating the study with the use of other source of bibliometric data, including databases showing a higher representation of publications written in languages other than English, and (3) deepening the understanding of the identified research fronts through conducting relevant systematic literature reviews [125, 126].

Highlights:

- The study of the effects of the SPARK physical education program in regard to physical activity of elementary school pupils by Sallis et al. (1997) is found to be the most cited publication in the physical education research field.
- The application of self-determination theory of motivation in physical education is the topic of other most cited publications in the field i.e. the works Standage et al. (2005), Standage et al. (2003), Ntoumanis (2001), and Ntoumanis (2005). The prominent and central position of these references is confirmed by the analysis of citation links – all of them are found to have the highest number of citation links within the sample.

- The systematic literature review and meta-analysis of research on application of self-determination theory in the physical education context by Vasconellos et al. (2020) is recognized as the publication of the highest value of the normalized number of citations.
- Normalized citations top rated references combine some very recent documents (2019-2020), highly cited publications from the 1990s and the 2010s and some older items dated as of the 1960s and the 1970s.
- The following research fronts in physical education studies have been identified through direct citation analysis: (1) 'motivation in physical education', (2) 'physical education programmes', (3) 'development of physical education', (4) 'self-determination in physical education', (5) 'physical education and students' academic achievement', (6) 'support of physical activity autonomy', (7) 'gender and physical education', and (8) 'long-term effects of physical education'.
- Combining the research fronts identified with co-word analysis and direct citation analysis, the two-dimensional matrix mapping the conceptual structure of the physical education research field has been developed. The matrix categorizes publications according to their themes and the age of students / the levels of education, which are the object of the analysed studies.

Conflicts of Interest

The authors declare no conflict of interest.

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