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Active Learning in an Environment of Innovative Training and Sustainability. Mapping of the Conceptual Structure of Research Fronts through a Bibliometric Analysis

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Abstract: The present study seeks to map and visualize up-to-date perspectives of the topic of active learning by analyzing and interpreting the different elements that make up learning ecosystems within the European Higher Education Area. With this aim, scientometric methods were employed to analyze a sample of 474 articles recovered from Web of Science (WoS) during the three-year period between 2018 and 2020. All articles examined the topic of active learning. Keywords (authors' keywords and 'keywords plus') from the manuscripts were examined through co-occurrence analysis in order to establish the conceptual structure of active learning. Among the different trends and emerging topics identified, there is an important presence of topics related to technology applied to the field of education, where digital contexts acquire a preponderant role in current education. These innovative changes focused on the digital updating and exploitation of technology represent a methodological challenge that requires an involvement and commitment to this new space for educational practice by teachers and students.

Keywords: active learning; teacher training; digital learning environments; information and communication technologies; bibliometric analysis

1. Introduction

The European Higher Education Area represented a seismic change in approaches to teaching–learning processes, whose development had previously been shaped, to a large extent, by universities. Thus, alongside [1], we believe that teaching–learning processes prior to the arrival of the Bologna Process fundamentally hinged on the teaching component and centered on content. In this sense, materials or the discipline itself represented the main axis of the teaching process, supplied through a type of training that was eminently technical. In contrast, in the new approach, the process passes from centering on student learning in itself, instead converting this into the epicenter of the process through vital training. This formation enables the student to acquire a set of skills and abilities that permit them to adapt to a globalized world and the knowledge society.

This act has contributed to students' personal constructions of knowledge in relation to that which they already know (prior knowledge), but were not consciously aware of possessing. From this perspective, to learn is to reconstruct knowledge based on one's own ideas, amplifying them or modifying them, as appropriate. This implies a construction process. On the other hand, teaching, from a teacher's standpoint, consists of mediating this process. Another basic element of the teaching–learning process is the curriculum. This consists of a program of activities, understood as learning situations in which students construct their own knowledge in a cooperative way and in a climate conducive to dialogue [2].

In this context, we must highlight that whilst teacher training in the use of active methods is not an entirely novel topic, it can certainly be considered to be highly relevant. Students are responsible for their own teaching–learning processes, with the teacher playing the role of researcher in the classroom, diagnosing and resolving learning problems. For this, it is necessary for planning to be flexible, able to be modified at any moment. Concepts are evaluated as skills, and the capacity to apply these skills to solving new problems is necessary. In this regard, the different methodologies of active learning play an important role. We highlight them by their importance and use service learning, problem-solving learning, cooperative learning, project-based learning, and case studies [3,4]. It is difficult to critically evaluate a model whose strategies, even in the present day, have not been implemented entirely as intended. Potentially, the severest criticisms made in this regard have been related to its epistemological basis, although others can also be found that are related to the mechanisms employed for identifying pre-existing ideas, psychological models of learning, and disparity in methods associated with the model [5]. Other criticisms include the fact that it considers a unitary concept of constructivism instead of a differential one [6], and that it is associated with a determined model of instruction [7]. Other criticisms are more related to limitations around the greater effectiveness of active learning, relative to other learning types, for developing competencies and abilities. A further criticism is the excessive implementation by authors (for example, obtaining funding in order to develop their research, attendance to scientific events on the topic, etc.) in studies where the superiority of active learning over other types of learning has already been demonstrated [8–10]. It is necessary, therefore, for this type of implementation to be counter-balanced by other studies in which the researchers are less invested in the outcome [11,12]. Thus, we agree with the following statement: "We are concerned the impressive learning gains documented in the active-learning literature may not be representative of what typical instructors are likely to obtain" [13] (p. 395).

Along these lines, from a bibliometric point of view, the present research seeks to illustrate general viewpoints around the topic of active learning and its relationship with learning ecosystems by examining scientific contributions in Web of Science (WoS) in a novel and similar way with respect to how other educational topics have been developed [14–16], taking into consideration the excellent advantages in calculation algorithms and graphical representations of computer tools such as Biblioshiny and VosViewer. Nonetheless, it would be useful to first define the term "learning ecosystems". Thus, this type of structure can be defined "as the complex of living organisms in a learning environment (e.g., students, educators, resources), and all their interrelationships in a particular unit of space (can be digital or physical)" [17] (p. 3). It is essential in a learning ecosystem to consider the way in which the main actors, namely, students and teachers, inter-relate, without forgetting the space in which these relationships are formed (both digital and physical) [18]. Nevertheless, it must be considered that these inter-relationships occur in different directions. Thus, in agreement with [19,20], we highlight that inter-correlations can be established between the main actors, between these actors and resources (content, learning methods, processes and evaluation tools, etc.), and, finally, between the resources themselves [21].

For this reason, the aim of the present research is to focus our efforts on mapping and visualizing the way in which different elements that make up active online learning ecosystems are grouped and organized. For this purpose, we will base our examination on keywords, including those provided by the authors (authors' keywords) and the database (keywords plus), as well as those extracted from articles selected for analysis. In our case, all scientific articles were published during 2018, 2019, and up until May 2020 in journals indexed in Web of Science (WoS). Co-authorship and co-citation analysis as well as analysis of associated words (associated word approach) identified keywords that appear together in documents, forming structures known as networks. These structures may be useful for understanding the research topic and making sense of what is important to denominated research fronts, whilst also being key to studying the evolution of research topics. Many research studies have demonstrated that this strategy is a good analysis option—for example [22–24]—and above all for visualizing results, as it has recently also been widely used in studies on educational research [25–29]. For this reason and as it is a strategy at the forefront in these types of studies, we opted for this research method. In this respect, we highlight that implementation of these techniques leads to the production of maps, graphs, and diagrams, from which conceptual, intellectual, and social patterns, trends, processes, and structures can be inferred from scientific contributions on the topic [30,31].

2. Materials and Methods

For data collection, two databases were considered: the WoS Core Collection and Scopus. As the Scopus base is broader and more extensive compared to WoS in terms of coverage of smaller scientific fields, education in Scopus would be within the field of Social Sciences, while WoS recognizes up to four categories of educational topics: Education and Educational Research; Special Education; Educational Psychology; and Education in Scientific Disciplines. This fact was decisive for opting for the WoS base because, although the final sample of Scopus was larger with more than 2000 results, many of those documents were far from the main theme of the study, while the vast majority of the final sample of the WoS was is also found in Scopus, and these are works whose themes respond best to the selected search parameters.

Manuscripts were recovered based on a search conducted on the 4th of May 2020 in the Web of Science database. The search was filtered by "topic", and the search terms 'active', 'learning*', and 'educat*' were entered alongside the Boolean operator "and". In the basic search of the WoS, three rows were added, independently introducing each search term in one row and establishing the Boolean operator "and" between all of them. Next, the search was restricted to the time period of 2018–2020, selecting only those documents that were empirical in nature, such as articles and reviews, and whose sources were only journals. Finally, the search was limited to the four thematic categories used by Web of Science for the field of education: Education and Educational Research; Education in Scientific Disciplines; Special Education; and Educational Psychology. In this way, a sample of 474 articles was established for the present research.

All records were exported to an unformatted text file, which we subsequently uploaded to the Biblioshiny package. For data analysis, the software program R v.3.6.1. was employed through the R Bibliometrix package [32]. Concretely, the simpler, more user-friendly interface of the Biblioshiny application was used to avoid the programming language used in R. This has a greater capacity to map scientific fields through relevant authors, sources, documents, or, as in our case, words. It is a novel and powerful tool that produces perfectly parameterized analysis, and is capable of revealing structural and dynamic aspects of scientific research [33,34]. The following table, Table 1, shows the main information retrieved from the examined sample of manuscripts.

Table 1. Main sample information.

Description	Results
Documents	474
Keywords plus	518
Authors' keywords	1608
Period	2018–2020
Article	454
Review	20

The variables analyzed included the titles and abstracts of articles, and, principally, the keywords that defined published content. In the present case, we differentiated between authors' keywords and keywords uncovered using the keywords plus feature. Authors' keywords consist of a list of terms considered by the authors to best represent the content of their article. These keywords are typically chosen prudently and should be processed in order to avoid potential bias. Keywords plus are generated by a computer via an automatic algorithm. They are words or phrases that frequently appear in the titles of articles referenced by the study, though they do not necessarily have to appear in the article title or authors' keywords. Garfield and Sher [35] stated that keywords are terms that capture the content of articles with great depth and variety. Article keywords help readers discover content and tighten the focus of research studies [36] by representing the nucleus and essence of the article. In other words, they provide a condensed summary that is specific to the topic and that, thanks to a high frequency of specified keywords, establish hot or trending topics in a specific field of study [37]. Keywords plus are as effective as authors' keywords in terms of performing bibliometric analysis to investigate knowledge structure in a determined scientific field. However, they may be less exhaustive when representing article content [38].

3. Results

3.1. Three-Field Plot Analysis

In order to generate the following field plot, four of the main meta-data fields were selected, namely: abstract, title, authors' keywords and keywords plus. For this, we examined in detail the main keywords provided by authors and the database, and those inferred from manuscript titles and abstracts. For the latter, the software processed the information in order to extract words from titles and abstracts, eliminating "empty words" and punctuation. Once the parameters were set, relationships were established between the 20 main topics to emerge from abstracts, titles, authors' keywords and keywords plus. This is summarized by a Sankey plot, analyzing agreement or flow between the various terms.

In Figure 1, relationships are observed between the 20 main author keywords (left field), 20 keywords inferred from article abstracts (middle field), and 20 keywords plus (right field). It can be appreciated from this combination of three variables that the terms with highest agreement values are those of "education" with 1044, "active learning" with 1013, "learning" with 1001, "students" (from keywords inferred from article abstracts) with 884, "higher education" with 797, and "students" (from keywords plus) with 544. With regards to relationships between terms, we found the highest flow values to pertain to "active learning—students" with 183, "students—education" with 173, "active learning—learning" with 170, "learning—education" with 156, and "higher education—students" with 116.

Figure 2 illustrates relationships between the 20 most relevant author keywords (left field), 20 main keywords inferred from article titles (middle field), and 20 most prevalent keywords using the keyword plus option (right field). It provides another perspective of the combinations present in the data and identifies that those terms with the greatest agreement values are the same as those seen in Figure 1, with the exception of the term "flipped classroom". However, different overall values were seen in relation to flow: "active learning" with 125, "learning" with 125, "higher education" with 124, "education" (from the keywords plus option) with 105, "education" (from keywords inferred from article titles) with 102, "flipped classroom" with 70, and "students" with 61. The relationships between relevant terms with the highest agreement values were "active learning—learning" with 24, "learning—education" with 22, "higher education—education" with 20, "active learning—education" with 17, "higher education—learning" with 16, "flipped classroom—flipped" with 16, "active learning—active" with 14, "learning—performance" with 13, and "flipped classroom—classroom" with 13.

We could highlight the terms "flipped classroom", "active learning", and "students" due to their importance. The reason for highlighting these terms is mainly based on the direct relationship they have between them in a changing and dynamic landscape such as the one that educational practice is experiencing. Taking the term "students" as the central axis, its relevance and involvement in new teaching methods that active learning contemplates are undeniable. In this way, given the advancement of technology and its increasing incursion into the classroom, learning modalities such as "flipped classroom" emerge that use different learning strategies, such as face-to-face and virtual strategies. This, together with some of the results that can be observed throughout this research, confirm the establishment of technology and digital contexts in education.

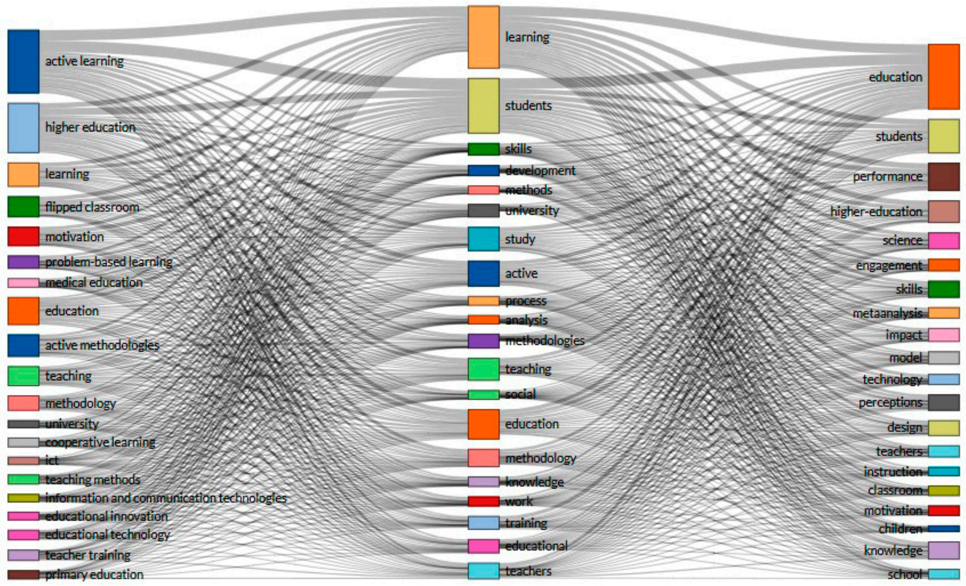

Figure 1. Summary of relationships between top author keywords, top abstract keywords, and top keywords plus.

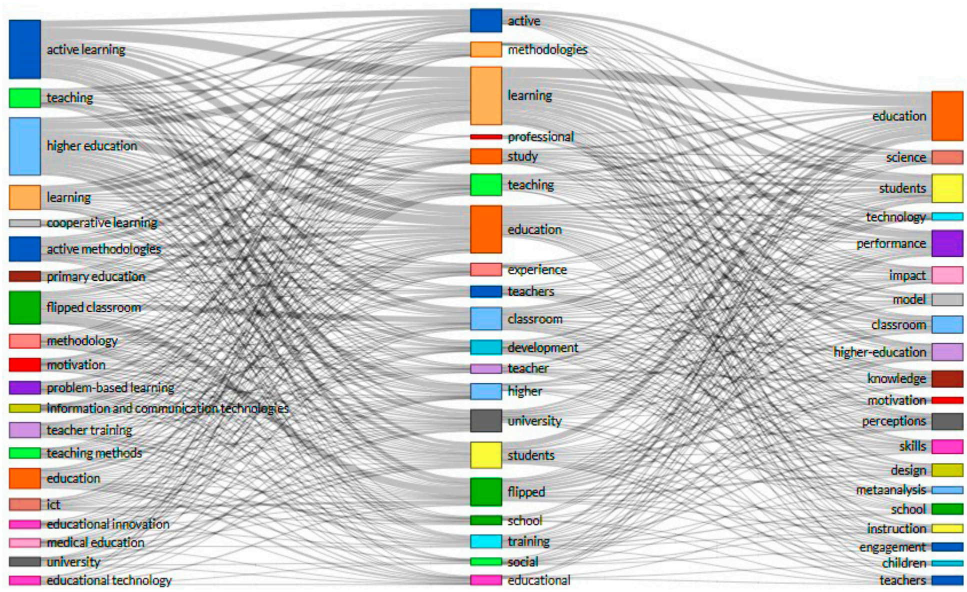

Figure 2. Summary of relationships between top author keywords, top keywords from titles, and top keywords from keywords plus.

3.2. Trending Topic Analysis

For the following analysis, we contemplated both author keywords and keywords identified using keywords plus. The aim of this was to establish trending topics for the year according to the sum of the frequencies at which each of the terms appeared. The following parameters were selected for both types of keywords: a minimum keyword frequency set to five and up to a maximum of 20 keywords per year. When applying these parameters, we found that, given that the year 2020 is still yet to finish, no term yet exists that can act by way of a keyword. As no keyword appeared a minimum of five times, it was established that no trending topic can yet be determined in any direction.

In the case of author keywords, it can be observed in Figure 3 that up to 27 terms were identified that complied with the selected parameters, although we have focused here only on the most pertinent. For the year 2018, we find that "teaching" appears 16 times. For the year 2019, we have "education" with a frequency of 26, "active methodologies" with 20, "motivation" with 13, "methodology" with 12, and "teacher training" with 10.

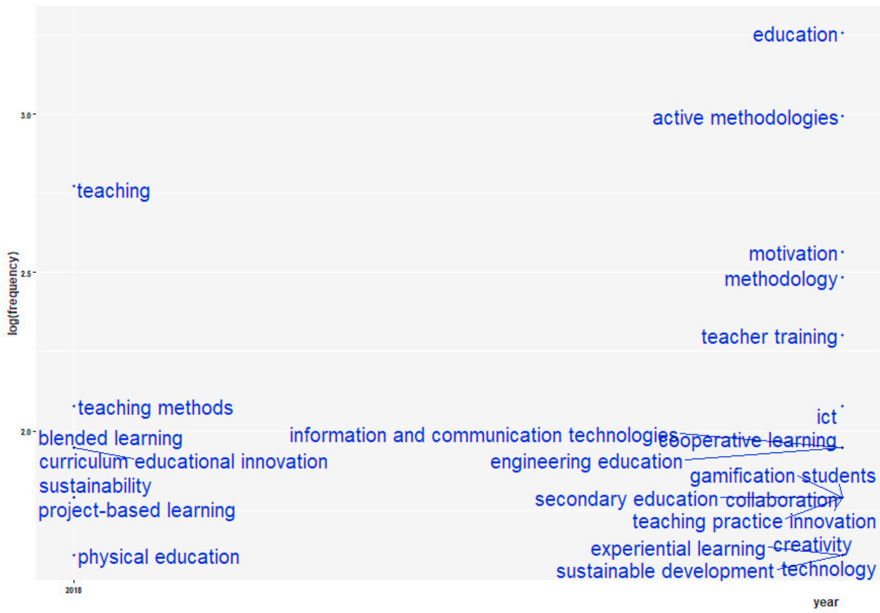

Figure 3. Trending topics established from authors' keywords.

Topics emerging from keywords plus are represented in Figure 4. We only found two topics to emerge in 2018 from a total of 17 terms. The two themes relating to 2018 are "methodology" with a frequency of 6 and "experience" with a frequency of 5. The most stand-out terms from 2019 were "higher education" with a frequency of 19, "knowledge" with 16, "model" with 13, and "classroom" with 12.

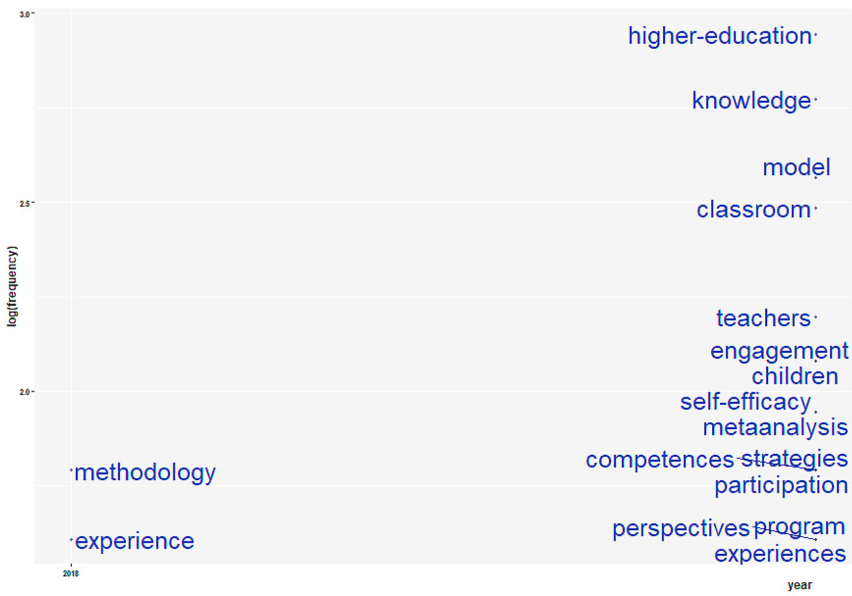

Figure 4. Trending topics established using keywords plus.

As can be seen in Figures 3 and 4, some of the most frequent trending topics do not provide information on specific aspects of education. This applies in the cases of "education", "higher education", or "methodology". This responds to universal concerns that education has maintained for decades and that remain perennial over time, since they are general and inherent themes of the discipline both in the field of practice and in educational research. However, one can also see other trending themes, such as "motivation", "classroom", "knowledge", "experience" or "ict- information and communication technologies", that may be marking a turn, as will be seen later with the analysis carried out, in favor of a digital teaching–learning context with a great presence of technology, and where the traditional models in which the classroom was conceived, the knowledge, or the motivation of the students undergo a transformation according to the current times and demands.

3.3. Keyword Co-Occurrence Analysis

Scientific mapping strives to find representations of intellectual connections within the dynamic system of scientific knowledge [39], investigating this knowledge from a statistical point of view. Specifically, we are going to study its conceptual structure. In other words, this structure represents the relationships between words in a set of publications via a network of associated co-words. The purpose of this is to deepen understanding of the scientific findings around main themes and topics (hot/trending topics) within active learning research frontiers.

In order to perform a co-occurrence analysis between the different words, network parameters were previously configured. With regards to the layout, we chose an "automatic layout" due to the fact that the program automatically chooses the best design for graph legibility. Various grouping algorithms are available for clustering, though in this case, we selected the "Louvain" algorithm. This is argued to be one of the best algorithms, alongside the "Walktrap" algorithm [40]. Finally, in order to standardize co-occurrences, we employed the measure of similarity, which is based on "Association Strength". Figure 5 shows the co-occurrence network formed between the 30 most relevant author keywords.

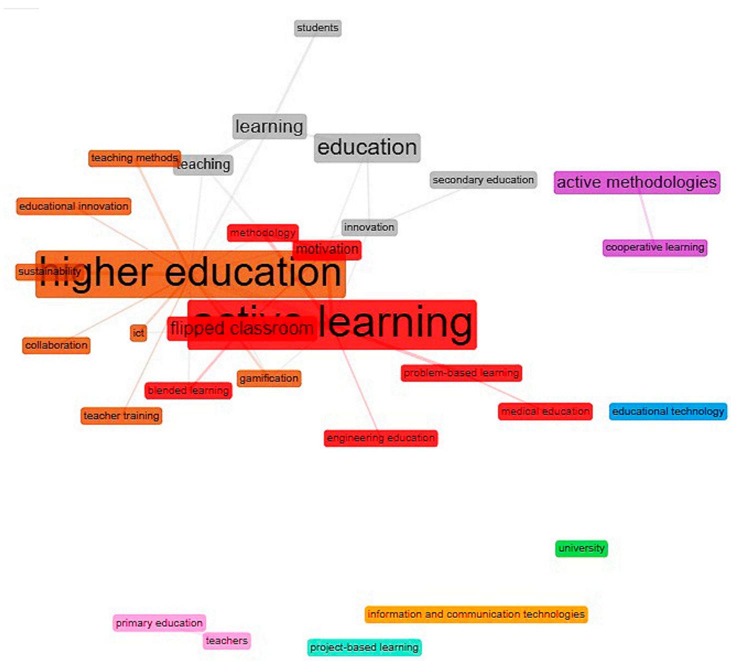

Figure 5. Co-occurrence network between the 30 main author keywords (2018–2020).

From this co-occurrence network of author keywords, a total of nine clusters are configured. The first cluster (red) includes the terms "active learning", "problem-based learning", "flipped classroom", "motivation", "methodology", "medical education", "engineering education", and “blended learning”. The second cluster (dark blue) comprises the term “educational technology”. The third cluster (green) comprises the term “university”. The fourth cluster (purple) includes the terms “active methodologies” and “cooperative learning”. The fifth cluster (orange) comprises the term “information and communication technologies”. The sixth cluster (brown) includes the terms “higher education”, “ICT”, “educational innovation”, “sustainability”, “gamification”, “teacher training”, “teaching methods”, and “collaboration”. The seventh cluster (pink) includes the terms “primary education” and “teachers”. The eighth cluster (gray) includes the terms “learning”, “innovation”, “education”, “teaching”, “students”, and “secondary education”, and, finally, the ninth cluster (light blue) comprises the term “project-based learning”. Interpretations from the network map are based on observations of node size and link size, with these being proportional to the extent of co-occurrence and co-occurrence coincidences, respectively. In this final sense, it is seen that the links in Figure 5 represent the size or bulk of similar links. Nonetheless, the same does not occur with node size in relation to the two topics that stand out from the rest: “higher education” and “active learning”. Both topics occupy a central position within the network. This indicates that these are the themes that most strongly relate to the other topics found on the outskirts or periphery of the map. In the same way, the clusters that belong to the brown cluster in relation to “higher education” and the red cluster in the case of “active learning” are the clusters that are most centrally located in the network and that possess the least density, as each one is composed of only eight topics. The Biblioshiny tool measures betweenness centrality as a form of network analysis. This relates to a general measure of centrality in a graph [41], which is based on the shortest path between nodes within the framework denominated by Graph Theory. This denotes that nodes with higher levels of betweenness centrality will have greater control over the network due to the fact that more information is passed through this node. In this case, the following values of betweenness centrality were found for the following nodes or topics: “higher education” with 130.96, “active learning” with 67.39, “learning” with 26.69, “innovation” with 23.80, “problem-based learning” with 20, “flipped classroom” with 9.18, “motivation” with 5.61, “education” with 4.66, “methodology” with 3.41, and “teaching” with 3.26. The remaining topics presented values lower than 0 for betweenness centrality.

The results obtained here show that the main interest is focused on general topics of educational research, such as “learning”, “education”, “methodology”, and “teaching”. However, other terms, such as “flipped classroom”, “active learning”, and “innovation” represent a slight continuation of the changes that occurred within educational practice in higher education classrooms, which were already intuited with the data obtained in the three-field analysis of field plots. If, at this point, the changes that mainly affect the teaching–learning process are not yet explored too deeply, in subsequent analyses, more details will be observed with presence of technology as one of the protagonists that can pose a methodological challenge for teachers and an academic challenge for the students.

We now proceed to analyze Figure 6, which illustrates the co-occurrence network between the 30 most relevant keywords according to the keywords plus tool.

In the co-occurrence network of keywords extracted from keywords plus, seven clusters were established, with the first cluster (red) including the terms “students”, “performance”, “impact”, “model”, “science”, “higher education”, “teachers”, “design”, “pedagogy”, “enterprise”, and “schools”. The second cluster (blue) comprises the term “motivation”. The third cluster (green) includes the terms “skills”, “instruction”, “school”, and “children”. The fourth cluster (purple) comprises the term “meta-analysis”. The fifth cluster (orange) includes the terms “technology”, self-efficacy”, and “engagement”. The sixth cluster (brown) includes the terms “education”, “knowledge”, “classroom”, “perceptions”, “experience”, “leadership”, “beliefs”, “strategies”, and “perspectives”, and the seventh cluster (pink) comprises the term “management”. Within this co-occurrence network of keywords established using keywords plus, the three most relevant nodes are found to be located in the most central part of the graph. Firstly, the topic “education” stands out due to its large size. This topic belongs to the brown cluster, which is one of the central clusters and the second least dense cluster, as it comprises only eight topics. The other two most important nodes, according to size, are the topics "students" and "performance". Both belong to the red cluster, which, at the same time, forms another large central cluster and is also seen to be less dense, with a maximum of only 11 topics being housed within it. Although, as occurred with the network in Figure 5, the size of the links turns out to be largely similar for the keywords plus network. For this reason, equality exists in the strength of relationships between topics. However, in some specific cases, a thicker link can be seen, with a greater strength consequently being seen in the relationships between terms, such as between "education" and "science", "beliefs" and "education", and "impact" and "students". With regards to the topics that present a value of betweenness centrality greater than 0 and, thus, execute greater control over the network, outcomes are as follows: "education" with 115.21, "students" with 80.01, "performance" with 54.24, "skills" with 31.71, "knowledge" with 26.90, "impact" with 9.79, "classroom" with 4.55, "model" with 4.41, "science" with 3.96, "technology" with 3.24," self-efficacy" with 2.43, "instruction" with 1.95, "higher education" with 1.38, "perceptions" with 0.71, "engagement" with 0.61, and "teachers" with 0.13. The remaining topics had betweenness centrality values of 0.

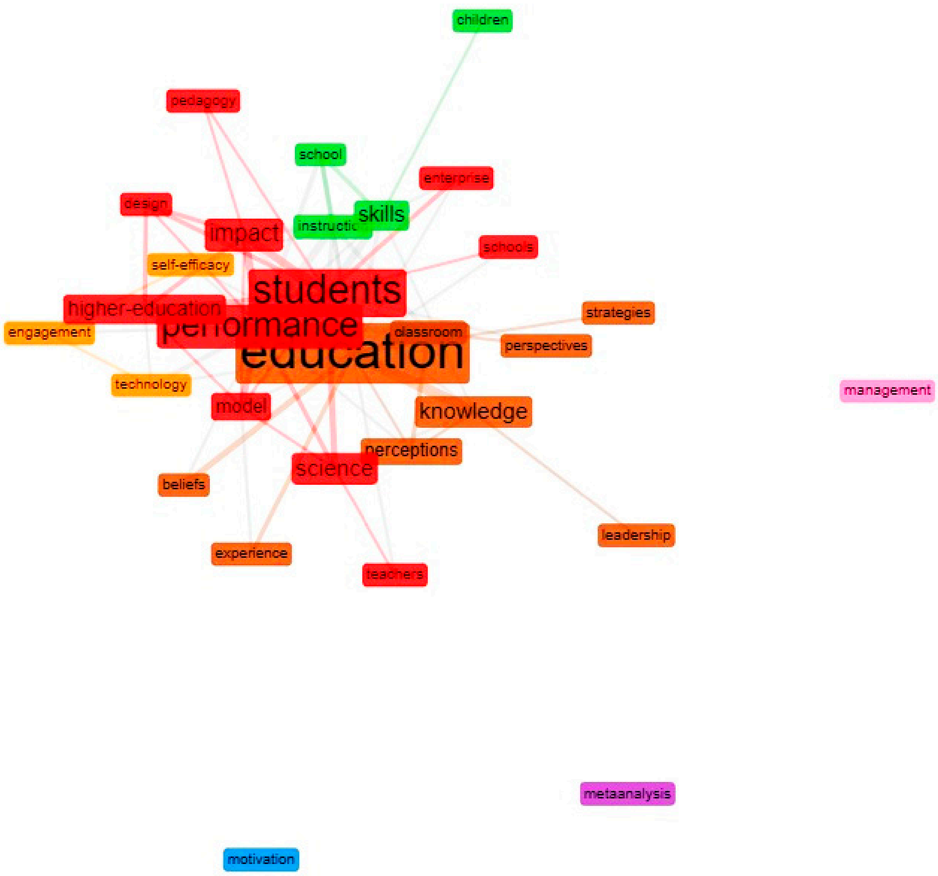

Figure 6. Co-occurrence network between the 30 main keywords using keywords plus (2018–2020).

Once again, everything turns around the topic "students"; now, it is more evident that the inclusion of technology will determine the changes necessary for a new educational context in the present and in the future. In this line, we find terms that are very close to the topic "students" and that take on a greater meaning in the face of this new panorama, such as "skills" and "perceptions", because this panorama will mean that a new type of learning that is increasingly removed from traditional teaching models. In the same way, these changes are a challenge for teachers, hence the importance of the terms "instruction", "model", "beliefs", and "knowledge". Therefore, if these changes focus on developments that concern the teaching–learning process, it is logical that many of the identified terms should be shared by both students and teachers to successfully face new educational demands in line with an increasingly modern and digitized society. Examples of these terms are: “performance”, “classroom”, “self-efficacy”, and “commitment”.

However, and at a general level after the analysis of Figures 5 and 6, as a curious fact, the absence of terms such as “mobile phone” or “smartphone” is surprising. Faced with a panorama of changes in educational practice with a greater presence of technology, it is striking that in this context, these terms do not appear, marking a new trend line in the field of education. More and more young people at earlier ages are those who have and easily handle these mobile devices, and for this reason, it is surprising that we miss these terms, as they belong to an educational tool that can be introduced little by little as part of active methodologies. The numerous applications (apps) that must exist with educational content or give an academic utility to mobile devices, always with the supervision of teachers, could be useful for this new digital context. Perhaps work will soon begin to appear in the scientific literature that includes mobile devices with educational implications, or they already exist, but can be recovered by conducting more exhaustive searches or with other search terms than those used for this research. In any case, if a keyword or term of this nature had appeared, its presence would not have surprised us in these times with a more digitized education.

Thematic Map Analysis

Thematic networks were identified through a conceptual structure network and co-occurrence analysis of keywords. Networks were traced according to a two-dimensional matrix attending to two types of measurement of the thematic network. Namely, these measures are centrality and density. Centrality is a global measure that provides information about the position occupied by a node in relation to the other nodes [42]. Nodes can adopt positions that are more central or preferential in the map [43]. In other words, centrality refers to the degree of external connectivity, with a greater or lesser number of relationships being possible from one node to another. This measurement can be interpreted as the importance of a theme to the research field of interest [18]. Density concerns a more local or egocentric measure, which is characterized by indicating the position of a determined node with respect to the set of neighboring nodes. It indicates the proportion of existing edges in relation to the possible edges between sets of neighboring nodes [42]. In other words, it refers to the degree of internal connectivity, which can be greater or lesser depending on the number of topics of varying nature that make up a determined node. It can be understood as a measure of theme development [44].

For the creation of thematic maps, we turned to software parameters and configured the analysis to contemplate up to 500 author keywords and 500 keywords from keywords plus. Furthermore, the minimum frequency of clusters was established at five. In other words, no keyword will form part of any cluster if its frequency is less than five. Within the thematic maps, each bubble represents a network cluster, and the name or label of that bubble is given by the word with the highest occurrence value. In addition, the size of the bubble is proportional to the number of word occurrences in the cluster. Finally, positioning of the bubble is established in accordance with measures of centrality and density. Due to the fact that each bubble comprises a cluster, we will interpret that cluster according to a label that corresponds to a research frontier. In this way, the theme developed is broader and more general. In reality, the label corresponds to the keyword with the highest occurrence value. For this reason, although the name of the research frontier and the name of the corresponding trending topic or theme are the same (in some cases, the bubble or cluster is even formed by a single keyword), we make this distinction between frontiers and topics because there is a main theme that groups, to a certain extent, with others with lower occurrence values in the same cluster that are acting as more specific trending topics.

The following figure, Figure 7, shows the thematic map of author keywords.

Taking as a reference the quadrants of the Cartesian axis, we find that the upper left quadrant (quadrant 3) refers to highly specialized and isolated themes. The lower left quadrant (quadrant 4) pertains to marginal themes or those that are in decline. The upper right quadrant (quadrant 1) relates to motor themes, and the lower right quadrant (quadrant 2) pertains to emergent themes [44].

In accordance with that previously stated, we can see that the nine largest bubbles or clusters obtained from analysis of authors' keywords correspond to emergent themes, such as "active learning", "active methodologies", "education", and "teaching". These clusters are central and, although they consist of a greater number of themes in their formation, they have less dense internal links. The bubble corresponding to "active learning" is composed of 16 keywords, with the following terms obtaining the greatest occurrence values: "active learning" with 55, "higher education" with 44, "flipped classroom" with 20, and "information and communication technologies (ICT)" with 15. Five keywords are grouped within the frontier of "active methodologies". These are "active methodologies" with an occurrence value of 20, "educational technology" with 8, "cooperative learning" with 7, "engineering education" with 7, and "technology" with 5. For the bubble denominated "education", four keywords are included, these being "education" with an occurrence of 26, "learning" with 20, "university" with 7, and "curriculum" with 7. Finally, the "teaching" cluster is composed of another four keywords, which are "teaching" with an occurrence of 16, "motivation" with 13, "methodology" with 12, and "creativity" with 5.

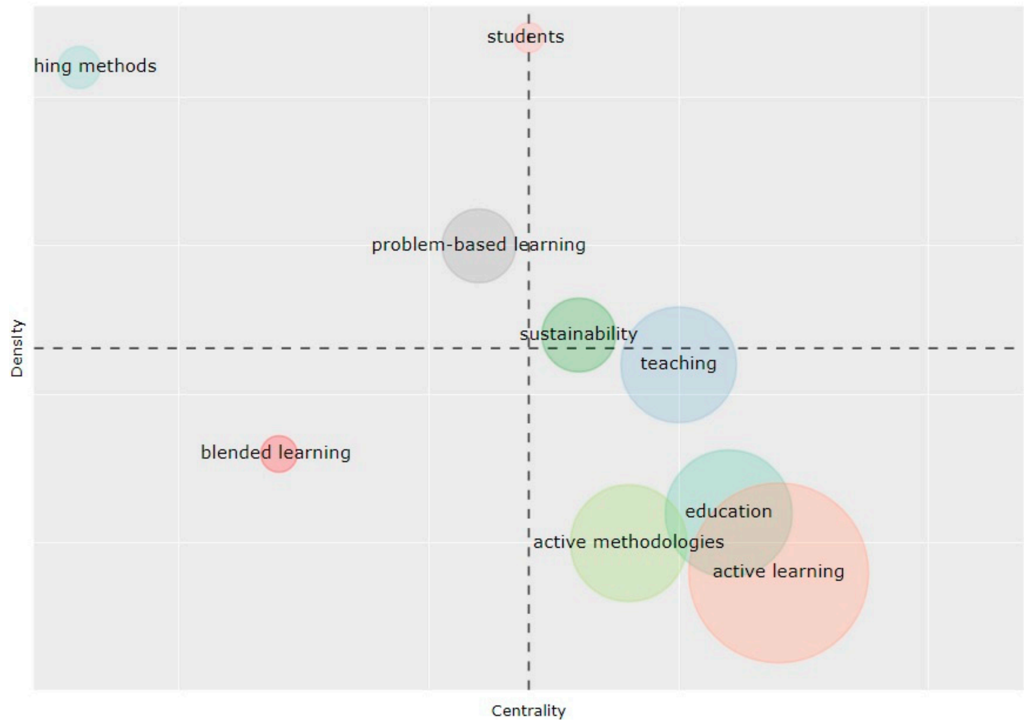

Figure 7. Thematic map of author keywords.

In view of the data obtained from the analysis of the authors' keywords, it is verified that the main topic studied in this research, such as "active learning", is an emerging topic at present that is setting new trend lines, mainly sponsored by the great rise of new technologies and new digital spaces and contexts in which educational practice takes place. For this reason, in the teaching–learning process, the presence of students gains greater strength, with special emphasis on higher education students.

The thematic map relating to keywords extracted using keywords plus presents some clusters with a more disperse spatial distribution. In this case, 10 bubbles emerge from this analysis, with a significant change in the case of the research frontier denominated "education". Before (Figure 7), this was an emerging theme, but now it is placed in the map as a clear motor theme. Of the ten bubbles, six are considerable in size due to the high number of word occurrences in the cluster. In this case, this highlights that some bubbles share more similarities than others. Centrality of the clusters "performance" and "students" confirms that, whilst these were previously shown to lie within the co-occurrence network of Figure 6, "performance" now emerges as an emerging theme and "students" as a marginal theme, or one that is in decline. These clusters are less dense, but include a greater number of terms or elements in their formations. For instance, the "performance" bubble is composed of seven keywords, highlighting "performance" with an occurrence of 26, "model" with 13, "classroom" with 12, and "instruction" with 10. The research frontier denominated "students" is composed of four keywords, including "students" with an occurrence of 32, "university" with 7, "competences" with 6, and "perspectives" with 5. The "education" cluster houses the terms "education" with an occurrence of 55, "knowledge" with 16, "strategies" with 6, and "program" with 5. The frontier denominated "technology" also stands out. This is composed of the keywords "technology" with an occurrence of 9, "engagement" with 8, "management" with 7, "self-efficacy" with 7, and "beliefs" with 6. The frontier denominated "skills" is also notable, including the terms "skills" with an occurrence of 15, "children" with 8, "motivation" with 7, and "experiences" with 5. Finally, we highlight the frontier "higher education", which is located between emerging themes and developed and isolated themes. It is formed by the terms "higher education" with an occurrence value of 19, "impact" with 15, and "design" with 11.

In this section, some specific aspects can be pointed out. In the first place, the fall from the topic "students" to the so-called marginal or declining topics is striking. On the other hand, the bubbles related to "technology" and "skills" stand out, such as those that mark the new emerging themes. This fact could be interpreted from the point of view in which the incursion of technology in the educational field is increasing, and the research focuses more on the methodological challenges that these changes entail within an educational digital context rather than the aspects related to the students, even though these remain the cornerstone of the teaching–learning process.

4. Discussion and Conclusions

The main objective of the present study was to analyze the theme of active learning within the context of educational research and its emergence in the learning ecosystem. The purpose of this was to identify the main trending topics related with elements that make up this ecosystem via keyword analysis of a sample of 474 scientific articles. Articles were recovered from the Web of Science database during the time period of 2018–2020. This type of strategy to consider WoS as a database under evaluation has been used in other works, including those of [25,26]. The reason for this choice is due to, on the one hand, the prestige of that database, and, on the other, to the fact that the WoS database is the most frequently used database for bibliometric studies in education. An example of this may be the current works of [27–29]. On the other hand, more and more papers where software tools are used for the construction and visualization of bibliometric networks based on information on different topics included this database [45–47].

4.1. Theoretical and Practical Implications

Given the panorama of research frontiers and hot or trending topics uncovered in relation to the research frontier of active learning, a significant presence of topics is appreciated relative to the technology applied to the field of education (quadrants 1 and 2 in the two obtained thematic maps). As we are already aware, in a thematic map, the quadrants 1 and 2 in the upper and lower section of the right-hand side share a degree of correspondence. In quadrant 1, we find the key central frontiers, which have intense internal links and represent the topic with greatest centrality. In the case of quadrant 2, the central frontiers appear due to their strong connection with other clusters, although these themes are not yet sufficiently developed, as the density of their internal links is relatively low [19].

In this sense, if we take into consideration the research schematic [48–50] pertaining to the elements that make up the ecosystem in which active learning is promoted, we see that this ecosystem seems to occupy a preponderant role in the digital context (digital learning space) in contrast to the physical context (physical learning space). In the educational context, clear trends are seen towards increasing technology use, replacing more traditional teaching–learning processes. We highlight that "the learning space is by analogy the physical environment in a traditional ecosystem, and includes information and digital resources like slides, lectures, etc., but also physical material like books, for example" [17] (p. 3). It is clear that learning processes are being adapted to new contemporary challenges, which demand the development of digital skills. Within these skills in the learning ecosystem, the resources element (resources) has an eminently technological format and takes on a preponderant role.

4.2. Findings of the Research

For this reason, the various analyses performed detected topics such as "technology", "information and communication technologies (ICT)", educational technology", "innovation", and "educational innovation", among others. Precisely, in recent works, as well as in [51,52], we find empirical evidence that points towards greater use of ICT and new technologies by both teachers and students. In these works, it is made clear that their use not only improves the development of classes, but is associated with greater competences for students [52–54]. Notably, in the thematic map shown in Figure 8, one of the bubbles is even labeled according to the research frontier of "technology", composing the terms "technology", "engagement", "management", "beliefs", and "self-efficacy". All these terms are also related not only to the improvement of student skills, but also to the positive assessment of new technologies as a shared learning strategy, both by students and by teachers [54,55]. These terms could be considered, both from authors' keywords and from keywords plus, as motor terms or emerging themes within the considered scientific field (active learning and learning ecosystems).

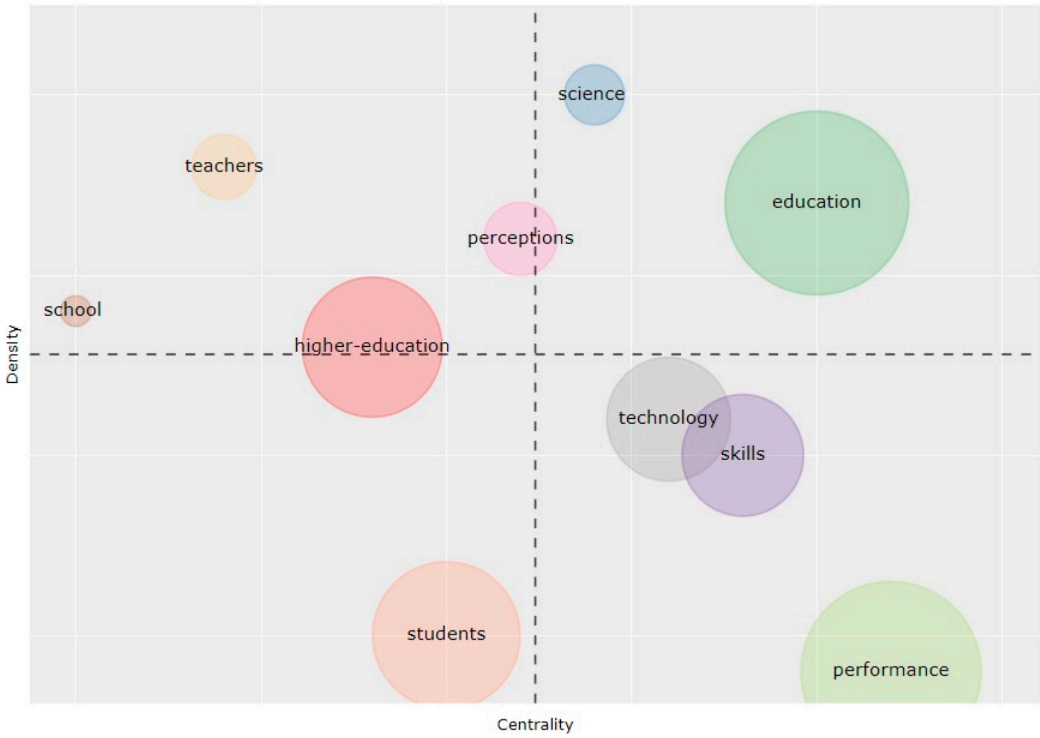

Figure 8. Thematic map of keywords extracted through keywords plus.

All of these changes and trending topics in education revolve around a topic that is both enduring and universal in the field, namely, "students". Specifically, this makes up the second main inter-related element of the learning ecosystem. This frontier achieved mixed results depending on whether authors' keywords or keywords plus were used. With the former, this topic acquires the status of motor theme, whilst, curiously, the opposite occurs when the latter approach is used, with this topic being relegated to a marginal theme. Despite this, "students" seems to become the cornerstone of teaching–learning processes, principally orientated (in the sample of articles studied) towards higher and/or university education. This is demonstrated through the identified topics of "higher education" and "university". These innovative changes bring them new challenges at a methodological level, as they imply the use of other tools and novel contexts requiring the acquisition of new knowledge. At this point, the identified research frontiers and hot topics make greater sense and take on greater meaning within the first highlighted element, i.e., resources, in the form of new methods of active learning. In this sense, the frontiers of "active learning", "methodology", "active methodologies", "flipped classroom", "knowledge", "model", "classroom", "skills", "performance", "blended learning", "problem-based learning", "project-based learning", and "teaching methods" stand out the most. In this regard, we highlight the works of [55–58] on the flipped classroom methodology. In these works, there is empirical evidence that the use of these active methodologies not only improves the competences of students, but also serves to make them aware of their future requirements, increase their motivation and involvement in the subjects they take, and also expand skills such as creativity. On the other hand, recent works by [59–62] on blended learning, problem-based learning, and project-based learning can be seen, as the topics addressed focus on the favorable opinions of students and teachers on these types of active methodologies, as well as on the acquisition of various kinds of skills. Through this overview, it can be observed that, over recent years, innovative actions have been aimed at digital updating and technological exploitation in the ambit of higher education through a series of active methodologies centered on students. It is true that no active learning method by itself has been shown to be the best for all learning contexts, with some studies even failing to find advantages of certain methods [13]. Nonetheless, in relation to these methods, it can be confirmed that when the responsibility for learning directly depends on the activity, engagement, and commitment of students, and when methods are more formative than informative, learning is produced that is deeper, more meaningful, and enduring. This may facilitate transference to more heterogenous contexts [49]. Thus, given that the present study considered scientific contributions from the period of 2018 to May 2020, it is not strange that, in the present study, they were considered as frontiers of important activity (motor themes) with a clearly emergent aspect of great topicality.

In contrast, it is surprising that the results obtained reveal the lack of importance of the frontier "teachers", as this element plays only a residual role in active learning. In this way, the thematic map corresponding to authors' keywords does not even refer to this theme, although the term "teaching" does emerge. When considering keywords plus, the frontier of "teachers" does appear in the thematic map; however, it is located in quadrant 3. In other words, it has high density but scant centrality. This means that, whilst the theme of teachers played a preponderant role in the past, researchers in the present day working in this scientific field have lost interest in this theme, turning it into a marginal theme.

Finally, of the two thematic maps obtained, we can infer two strategic structures of the updated scientific network (types 2 and 3) depending on the relative number of themes housed by each quadrant. In agreement with [50], we can consider three types of strategic organizations. Within type 1, themes are distributed around the bisector joining quadrants 1 and 4. None of the outcomes of the present study conformed to this organizational type. Within type 2, themes are distributed around the diagonal formed between quadrants 2 and 3. This type corresponds to the structure formed using authors' keywords, and indicates that the network is on the road to being formed or, in contrast, to disappearing. This is seen in the fact that barely any motor themes are found and, whilst emerging and highly specialized themes are seen, they are shown to be decreasing. Finally, type 3 is one in which distribution is dispersed between the four quadrants, with this corresponding to the outcomes produced using keywords plus. This type of structuring for strategic networks is more complex and diverse. It incorporates central, peripheral, and well-developed themes with little internal cohesion. Structuring of this type is indicative of a good dynamic in the field of study.

4.3. Limitations and Future Work

Future research studies should be oriented towards addressing a limitation that we acknowledge to have characterized the present study and essentially relates to the short time period studied. It was our intention to limit the present research to the period 2018–2020 (data for the year 2020 are incomplete, as the year has not yet finished) in order to obtain the most important hot topics and trending topics in the general field of active learning. The study specifically targeted educational research by examining the latest articles published in high-impact scientific journals; thus, this short timeframe was reasonable to meet the objectives established in the present study and through the specified analysis. Perhaps, examining a longer timeframe could complement the present study by obtaining a more complete picture of the active learning research frontier with regards to its development and growth over time. A retrospective longitudinal study could also better illustrate the evolution of themes (emerging hot topics and declining cold topics) according to broader timeframes. Furthermore, future research could go a step further and contemplate other variables aside from the keywords that are so crucial for the detection of main themes, and analyze the most productive authors, institutions, and collaboration networks at both a local level and between countries, etc. This calls for an examination of relevant intellectual and social structures.

Given these findings, it is worth asking some questions: Are education professionals prepared to successfully face these changes with a greater presence of technology? Are the new digital contexts in education available to everyone? Can a training gap be created between those who can have access to this new educational model and those who do not? For the first question, it would be necessary to inquire into the programs of the subjects that future education professionals study in their universities and check if the contents are in line with the new educational reality A continuous education that serves as recycling to the new times of all those teachers who develop their work and need to adapt to the new demands of the educational system is also essential. The second question could be more relevant than ever as a result of the current crisis due to Covid-19 and the situation of teleworking and distance education. Many families do not have the material and economic resources necessary for an education with an increasing presence of technology. This can be aggravated if we take into account the third question, since a gap can occur between students in terms of educational training and the use of technology in a society that increasingly demands more and better technological skills. This can happen if we take into account the locations of families and educational centers. Rural contexts, in comparison to cities, may on many occasions (although not necessarily always) find greater difficulties in being able to successfully approach the teaching–learning process that new active methodologies, active learning, and digital contexts impose with greater force nowadays. The thematic trends identified in this work and the discussion and conclusions that have been reached may represent the beginning of more research around all these questions and proposals that investigates in a more profound way educational practice, which, if necessary, requires examination of the political and social implications to cover the entire population or educational community.

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