



UNIVERSIDADE FEDERAL DE ALAGOAS
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**POSITIVE ARTIFICIAL INTELLIGENCE IN EDUCATION (P-AIED): A
BIBLIOMETRIC ANALYSIS**

Maceió – AL

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Artigo científico apresentado ao Instituto de Psicologia da Universidade Federal de Alagoas – UFAL, como requisito total para a obtenção da nota final do Trabalho de Conclusão de Curso (TCC).

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Positive Artificial Intelligence in Education (P-AIED): A Bibliometric Analysis

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Abstract The unprecedented global movement of school education to find technological and intelligent solutions to keep the learning ecosystem working was not enough to recover the impacts of COVID-19, not only due to learning-related challenges, but also due to the raise of negative emotions, such as frustration, anxiety, boredom, risk of burnout and the so-called “Covid fatigue”. Although this is not a new problem, it was deepened during the pandemic and we need to face old and new challenges in different ways. Despite focusing only on the inefficiencies of the learning system as well as in the hegemony of solutions to tackle the learning gap, we also need to shed light on the strengths and the positive aspects of the learning process to promote wellbeing. As highlighted by John Self, an intelligent tutoring system would behave as if it genuinely cared about the student’s success. This note from John Self shed the light on the importance and reflection of what success means and for whom. The goal of this study is to present a bibliometric survey about positive psychology and artificial intelligence in education, as the so-called Positive Artificial Intelligence in Education (P-AIED). The search string was performed in 2021 and the total number of studies gathered were 10777. After all the PRISMA steps, 256 studies were approved according to the inclusion criteria. The main conclusions were the high number of institutions and researchers with a related publication indicates a new trend for the community of AIED; the high number of collaboration from different countries indicates a possible global movement towards P-AIED; Positive Emotion and Engagement were the main Positive Psychology constructs identified in the studies; the lack of well-grounded theories of Positive Psychology indicates a great research opportunity; Positive Learning Analytics (P-LA), Positive Educational

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Data Mining (P-EDM) and Positive Intelligent Tutoring Systems (P-ITS) are three hot topics for P-AIED.

Keywords Artificial Intelligence in Education, Positive Psychology, Learning, Wellbeing

1 Introduction

The field of Artificial Intelligence in Education has decades of scientific contributions not only in every step of student's thinking process, but also how to model complex teacher and tutor pedagogical strategies as well as other dimensions of the humans interacting in the system such as dealing with emotions. However, just as highlighted by Ryan Baker, there is a disconnect of what Intelligent Tutoring Systems could be and what they are []. An intelligent tutoring system would not just be capable of supporting learning, but also promote the wellbeing of studies. An intelligent tutoring system would behave as if it genuinely cared about the student's success (Self 1998). This note from John Self shed the light on the importance and reflection of what success means and for whom, and such a reflection is more than needed in times of pandemic.

The pandemic caused negative impacts in all the areas, from education to health and economy. It is unprecedented for the global movement of school education to find educational technology (EdTech) solutions to keep the learning ecosystem working. Such a movement has been used to motivate a full-scale substitute for the traditional instruction by looking at the academic outcomes. Nevertheless, the pandemic also deepened problems related to the lack of engagement and negative emotions, such as frustration, anxiety, boredom, risk of burnout and the so-called "Covid fatigue". We need to face old and new challenges in different ways. Despite focusing only on the inefficiencies of the learning system as well as in the hegemony of solutions to tackle the learning gap, we also need to shed light on the strengths and the positive aspects of the learning process to promote wellbeing. To date, there is vast information about the real impact of covid-19 on academic outcome and wellbeing. Solutions had been designed to improve academic performance or promote wellbeing, but few studies from the field of Artificial Intelligence in Education are observing how to improve academic performance and promote wellbeing at the same time.

The community interested on the promotion of Wellbeing is called Positive Psychology and it there are several studies regarding Positive Education. Nevertheless, there is no systematization on the studies regarding Positive Education (or Positive Psychology) and Artificial Intelligence in Education. For this reason, we propose in this paper the concept of Positive Artificial Intelligence in Education (P-AIED). From an epistemological viewpoint, P-AIED concerns with the application of AI to Education to promote both learning and wellbeing, with twofold goals: firstly, research on how AI can be applied to develop individual strengths and personal motivation to promote learning;

secondly, research on how positive education can be applied on the design, development, innovation and transformation of intelligence systems to promote wellbeing in educational settings. In these kind of study, it is investigated, for example, how theories like flow-theory based design could improve knowledge acquisition and promote the well-being of high school students at the same time.

Although such a conceptualization was not proposed, there are several studies that some how consider the use of positive psychology concepts or techniques in AIED as well as the use of Artificial Intelligence in Positive Psychology. The goal of this study is to propose a bibliometric survey about positive psychology and artificial intelligence in education. It is intended to identify and understand how the intersection of Positive Psychology and Artificial Intelligence in Education can support the promotion of learning and well-being of students, teachers, and other educational stakeholders. In the following section, the methods and data sources used are presented. The obtained results are described in Section 3, and discussed in Section 4.

2 Methods

The bibliometric survey was made by following the methods of Systematic Mapping, which is a means of identifying, evaluating and interpreting the available research findings related to a research question, topic area, or phenomenon (Kitchenham & Charters, 2007). The main purpose was conducting a systematic mapping to extract the bibliometric information gathered evidence on which to base conclusions.

In order to perform this bibliometric analysis, the guidelines and the protocol template proposed by Kitchenham & Charters (2007) were used. The SLR process includes several activities, which can be grouped into three main phases: planning of the systematic study, conducting the and reporting the results. It consists of the following steps: i) identification of the need for the study; ii) formulation of a focused research question; iii) a comprehensive, exhaustive search for primary studies; iv) identification of the data needed to answer the research question; vi) data extraction; vii) summary and synthesis of study results; viii) interpretation of the results to determine their applicability; and ix) report-writing.

A software tool, called Sumarize [REF], was used to support the protocol definition. It is used to provide support to researchers conducting systematic studies. Sumarize extended the software tool Parsifal, which has been empirically evaluated and it was demonstrated that such tool had positive results in the execution of systematic studies [REF].

2.1 Research questions

This bibliometric survey's purpose is to identify and understand how the intersection of Positive Psychology and Artificial Intelligence in Education can

support the promotion of learning and well-being of students, teachers, and other educational stakeholders. Thus, we intend to answer the main research question:

For this reason, the two high level question of this study is:

HLQ1: *How Artificial Intelligence has been applied in Positive Educational Technology?*

HLQ2: *How Positive Psychology has impacted Artificial Intelligence in Education?*

Based on the high level questions, specific questions were raised according to P-AIED aspects that we are interested. The questions, along with their descriptions and motivations are described in Table 1.

Table 1 Research questions and motivations

Research Question	Description and Motivation
RQ1. How has the scientific output with regards to P-AIED developed over time?	This question provides a starting point to understand how the sub-field of P-AIED has published their research over time;
RQ2. Which countries contribute the most to the scientific output with regard to P-AIED?	This question intends to identify what are the countries of the authors as well as continents;
RQ3. What paper types are mostly used to convey new research results with regard to P-AIED?	This question aims to describe the type of paper P-AIED community has published their research;
RQ4. What are the publishing venues through which the results of P-AIED research are most often disseminated?	The answer to this question allows to identify what are the main venues for these researchers;
RQ5. In the context of which research areas and topics are the problems of P-AIED addressed?	This question provides a starting point to understand which are the main concepts of Positive Psychology and AIED been considered;
RQ6. Which scientific institutions are involved in the research on P-AIED?	This question intends to analyze which institutions have contributed to P-AIED;
RQ7. What are the most prolific authors contributing to the research on P-AIED?	This question intends to analyze which authors are somehow leading the research related to Positive Psychology and AIED;
RQ8. Is there a wide collaboration among researchers of P-AIED?	This question intends to analyze if such studies provide some evidence that the authors are collaborating with each others to develop the research on this sub-field;
RQ9. Are there results of P-AIED research widely acknowledge or do they only reach a small group of followers?	This question intends to analyze if such studies provide some evidence of acknowledgement based on the number of citations the studies have.

2.2 Inclusion and exclusion criteria

The aim of defining a criterion is to identify those primary papers which provide direct evidence about the research questions and also to reduce the likelihood of bias (Kitchenham & Charters, 2007). Note that we consider as primary papers the studies which present some kind of proposal to the area or present some kind of empirical evaluation of its contributions, whereas secondary papers are studies which only review a topic area, e.g., surveys, systematic literature reviews or systematic mappings.

Studies were eligible for inclusion in the review if they presented a peer-reviewed primary study and that presented some contribution on P-AIED. Studies were excluded if they were secondary, short papers, non-peer reviewed, duplicated, non-English written, gray literature papers (e.g., books, theses, dissertations and so on), position papers and if their focus was not using P-AIED. The summarized inclusion and exclusion criteria are presented in Table 2.

Table 2 Inclusion/exclusion criteria

#	Inclusion Criterion
1	Primary studies
2	Peer-reviewed studies
3	Studies that use authoring tool to design ITS for non-programmer authors
#	Exclusion Criterion
4	Secondary studies
5	Short-papers (≤ 5 pages)
6	Non peer-reviewed studies
7	Duplicated studies (only one copy of each study was included)
8	Non English written papers
9	Gray literature
10	Position paper
11	Non-empirical studies
12	Papers not framed in the Context of Education
13	Papers that does not approach Artificial Intelligence
14	Papers that does not approach Positive Psychology

2.3 Sources selection and search

The search strategy included only electronic databases and was validated by experts on Positive Psychology and AIED. According to Chen's recommendation (Chen et al., 2010), the following electronic databases were automatically searched: ISI Web of Science¹, Scopus², ACM Digital Library³, IEEE Xplore⁴ and Compendex⁵. Due to the context of Psychology, We also added the following digital libraries as recommended by experts: ERIC⁶ and PsycInfo⁷.

Fig. 1 shows the systematic process and the number of papers identified at each stage. In order to reach the goals and answer the research question, it was defined the PRISMA checklist and the use of PICOC (Population, Intervention, Comparison, Outcome, and Context) to support the systematization of the work. PICOC applies with an AND operator together with a set of OR operator for each dimension in order to build the search string. In this case, the string considered the dimensions of intervention (i.e. *positive psychology*), outcome (i.e. *outcomes of research*) and context (i.e. *positive psychology, educational technology, and AIED*).

In Step 1 the studies were obtained from electronic databases using the following search terms:

¹ <http://apps.webofknowledge.com>

² <http://www.scopus.com>

³ <http://dl.acm.org/>

⁴ <http://ieeexplore.ieee.org>

⁵ <http://www.engineeringvillage.com/>

⁶ <https://eric.ed.gov>

⁷ <https://psycnet.apa.org/home>

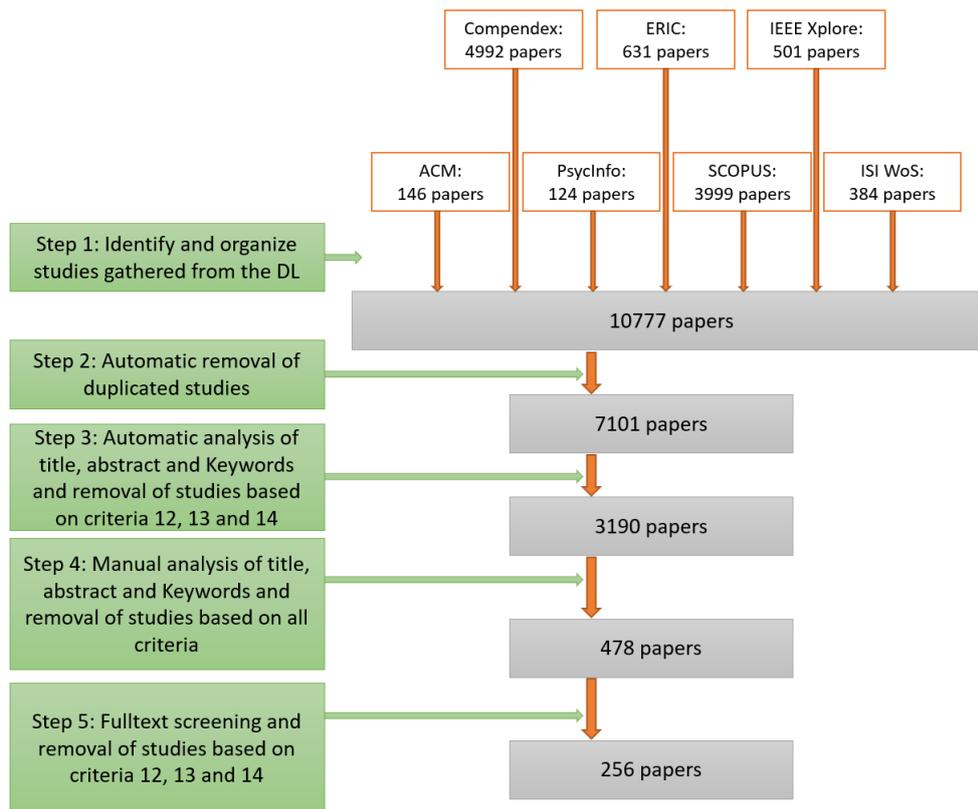


Fig. 1 Paper selection flowchart

- (1) "computers and education" OR "e-learning" "m-learning" OR "mobile learning" OR "tv learning" OR "web-based education" OR "adaptive educational" OR "hypermedia systems" OR "adaptive educational systems" OR "adaptive learning systems" OR "collaborative learning" OR "computer-supported collaborative learning" OR "educational environment" OR "educational system" OR "learning environment" OR "learning management system" OR "massive open online courses" OR "mobile learning" OR "t-learning" OR CSCL OR MOOCS OR "intelligent educational system" OR "Intelligent tutoring system"
- (2) "Artificial Intelligence" OR "Data Mining" OR "Learning Analytics" OR "automated tutor" OR "deep learning" OR "expert system" OR "intelligent agent" OR "intelligent support" OR "machine intelligence" OR "machine learning" OR "natural language processing" OR "neural network" OR "personal tutor" OR bayes*
- (3) Engagement OR "optimal experience" OR "optimal learning experience" OR autotelic OR flow

- (4) “Positive Psychology” OR blessing OR flourish* OR forgiveness OR happiness OR happy* OR mindfulness OR optimism OR “positive intervention” OR “positive psychological intervention” OR “positive psychology intervention” OR reframing OR reminiscence OR savoring OR strengths OR values OR well-being OR wellbeing
- (5) “Positive Emotion” OR admiration OR affection OR altruism OR amusement OR awe OR cheerfulness OR confidence OR contentment OR eagerness OR elevation OR enjoyment OR enthusiasm OR euphoria OR gratitude OR hope OR inspiration OR interest OR joy OR kindness OR love OR pride OR relief OR satisfaction OR serenity OR surprise
- (6) achievement OR accomplishment
- (7) meaning OR purpose
- (8) “positive education” OR grit OR passion OR resilience
- (9) relationships
- (10) outcome OR effect* OR effic* OR evaluat*

These search terms for P-AIED was combined considering two main categories: i) Positive Psychology: PERMA (acronym for P = Positive Emotion; E = Engagement; R = Relationship; M = Meaning; A = Achievement) construct is the most well-known construct was taken into account as well as Positive Education; ii) Computers and Education: different terms were considered based on previous systematic studies []; iii) Artificial Intelligence: the main techniques used nowadays in AIED society were considered; and iv) Outcome: to ensure the gathered studies are primary studies. The string was composed in the following way:

- (1) AND (2) AND (3 OR 4 OR 5 OR 6 OR 7 OR 8 OR 9) AND (10)

The search string was performed in the first semester of 2021 and the total number of studies gathered were 10777. After that, duplicated studies were removed (i.e. 3676 studies removed) and we applied a natural language processing algorithm to title, keywords and abstract to automatically reject not adequate studies (i.e. 3911 studies rejected). Finally, a manual exclusion following the criteria was performed and 2712 studies were removed. In total, 478 studies were approved according to the inclusion criteria and data will be extracted. Finally, a fulltext reading of the papers was conducted and 256 papers were selected in the final stage, as described on Figure 1. The next steps of the study was to run bibliometric analysis to answer the raised research questions.

3 Results and analysis

A total of 256 studies met the inclusion criteria and their data were extracted. The next subsections presents the results according to each research question.

3.1 RQ1. Scientific Output over time

The reviewed papers were published between 2006 and 2021. From a temporal point of view (Fig. 2), we can note an increasing number of papers throughout the years, but in the last five years (after 2016) the number of studies is higher and more balanced. Then, as shown in the figure, the year of 2019 has the highest number of publications. It is also worth noting that there is a clear balance of studies in most of the years and this means the research on Positive Education using AI techniques as well as on AIED using Positive Psychology techniques are increasing.

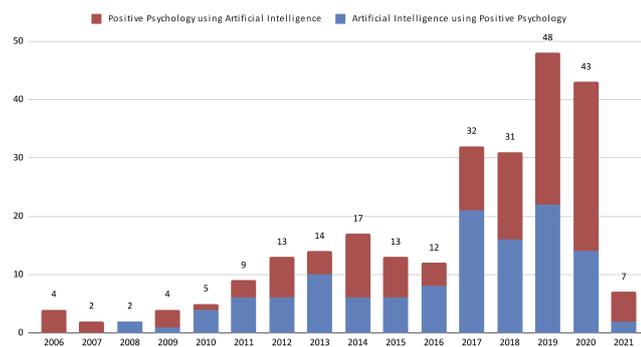


Fig. 2 Number of publications per years

Although there are more publications in the last years, the number of citations varies on which the years of 2021, 2017 and 2011 are the top 3 in the number of citations. Moreover, there is not a balance of citations based on the sub-field, which means there is not yet a predominance of a sub-field in detriment of the other.

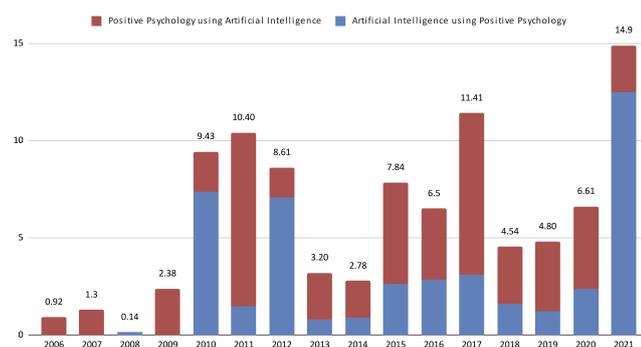


Fig. 3 Average of citations of articles per years

3.2 RQ2. Geographic Distribution of Scientific Contribution

The 4 provides a visual representation to answer RQ2, showing the geographic distribution of the research for both Positive Psychology using Artificial Intelligence and AIED using Positive Psychology. Researchers from all of the continents contributed to the advance of P-AIED. Researchers from exactly 50 countries contributed with the research on P-AIED on which the 5 countries with more scientific contributions are (for more details, see Appendix, Table 4: USA (152 studies, 30.1%); China (67 studies, 13.27%); India (39 studies, 7.72%); Canada (32 studies, 6.34%); and Spain (22 studies, 4.36%).

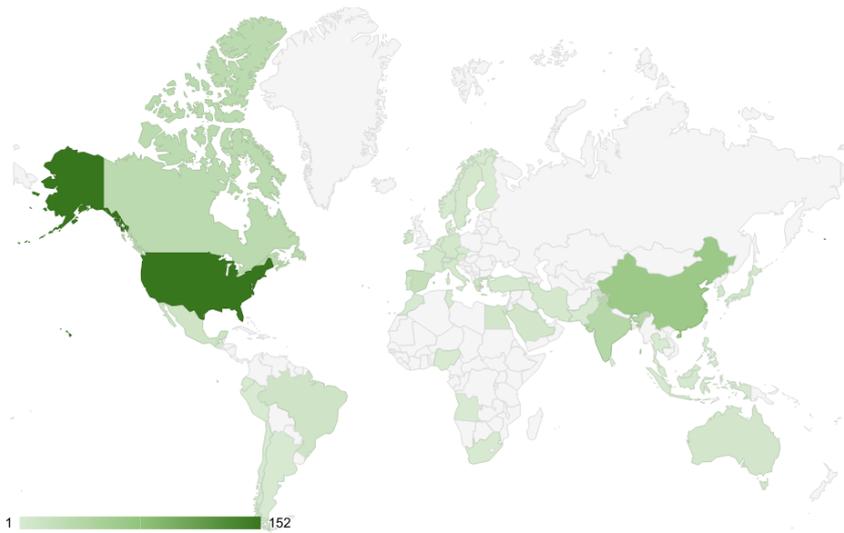


Fig. 4 Scientific publications per countries

Additionally, Figures 5 and 6 present the results per sub-field. Although it is possible to observe some differences, the top five countries are still the same aforementioned. On the other hand, there still contributions from all of the continents. This indicates the field of P-AIED is disseminated across the globe with contributions from different cultures (for mode details, see See Table 4 in Appendix 5).

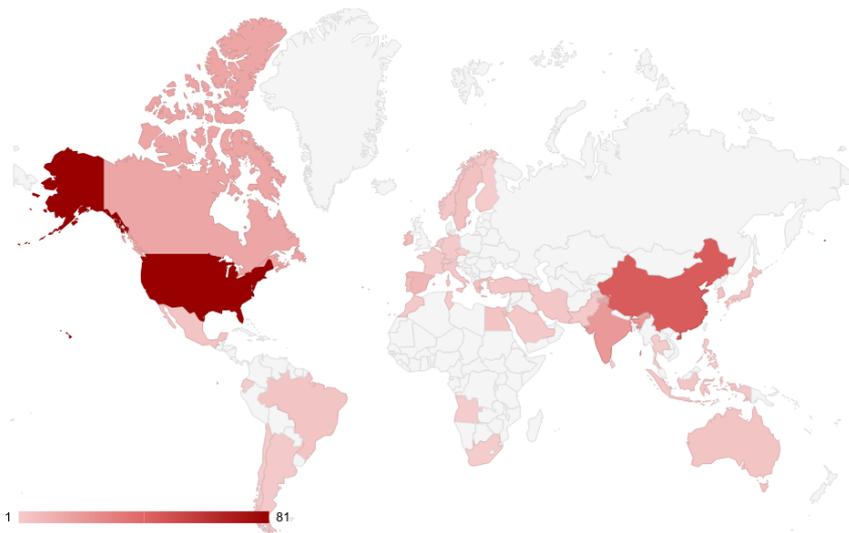


Fig. 5 Scientific publications of positive psychology using artificial intelligence per countries

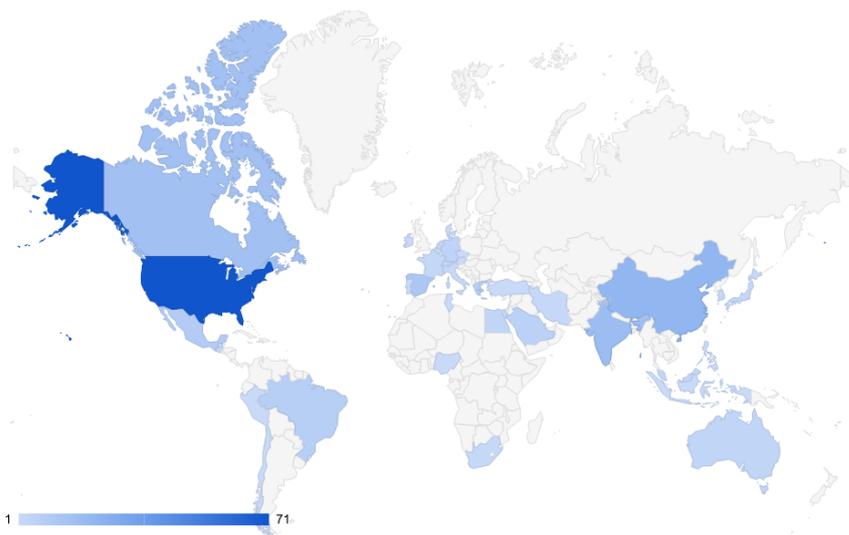


Fig. 6 Scientific publications of artificial intelligence using positive psychology per countries

3.3 RQ3. Forms of publication

The studies included (see Fig. 7) in this review may be a journal, conference, workshop or book chapter publications. The majority of studies are confer-

ence papers (61.7%; 158 studies), followed by journal publications (37.5%; 96 studies) and book chapter publications (only 2 studies). This pattern is also present whether to AIED using Positive Psychology or Positive Education using Artificial Intelligence.

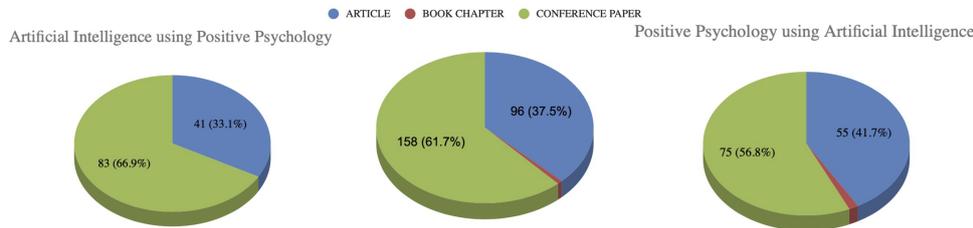


Fig. 7 Number of publications, percentages and their respective types

3.4 RQ4: Dissemination Channels

In response to RQ4 regarding the dissemination channels, Table 3 presents the distribution of selected studies over publication sources, including the publication name, type, count (i.e., the number of selected studies from each source), and the percentage of selected studies. The selected studies are distributed over 25 publication sources.

As shown in Table 3, the leading venues in this study topic are the International Journal of Artificial Intelligence in Education (IJAIED), followed by the International Conference on Intelligent Tutoring Systems (ITS), International Conference on Artificial Intelligence (AIED) and the International Conference on Artificial Intelligence workshops. These results are expected since most papers on ITS are published by these communities, but might also indicate a positive aspect in the quality of the papers included in this review since the leading venues are high reputation vehicles in ITS research. However, a great number of the publications about the topic is widespread in different venues from computers and education, and artificial intelligence research areas.

Table 3 Distribution of studies over publication sources.

Publication Source	Type	Count	%
International Journal of Artificial Intelligence in Education	Journal	7	21.2%
International Conf. on Artificial Intelligence in Education (AIED)	Conf.	2	6.1%
International Conf. on Artificial Intelligence in Education (AIED) Workshops	Workshop	2	6.1%
International Conf. on Intelligent Tutoring Systems (ITS)	Conf.	2	6.1%
Advances in Intelligent Tutoring Systems	Book Ch.	1	3.0%
Annual Conf. on Behavior Representation in Modeling and Simulation (BRIMS)	Conf.	1	3.0%
Computers and Education	Journal	1	3.0%
Expert Systems with Applications	Journal	1	3.0%
IASTED International Conf. on Computers and Advanced Technology in Education (CATE)	Conf.	1	3.0%
Ibero-American Conf. on Artificial Intelligence (IBERAMIA)	Conf.	1	3.0%
IEE Students' Technology Symposium (TechSym)	Conf.	1	3.0%
IEEE Transactions on Learning Technologies	Journal	1	3.0%
International Conf. on Artificial Intelligence (ICAI)	Conf.	1	3.0%
International Conference on Foundations of Augmented Cognition	Conf.	1	3.0%
International Conf. on Information Technology: New Generations (ITNG)	Conf.	1	3.0%
International Conf. on Information, Intelligence, Systems and Applications (IISA)	Conf.	1	3.0%
International Conf. on Intelligent Interactive Multimedia Systems and Services (IIMSS)	Conf.	1	3.0%
International Conf. on Knowledge-Based and Intelligent Information and Engineering Systems (KES)	Conf.	1	3.0%
International Journal on Learning Technologies	Conf.	1	3.0%
Journal of Information Science and Engineering	Journal	1	3.0%
Knowledge-Based Systems	Journal	1	3.0%
Mexican International Conf. on Artificial Intelligence (MICAI)	Conf.	1	3.0%
Object-Oriented User Interfaces for Personalized Mobile Learning	Book Ch.	1	3.0%
World Congress on Information and Communication Technologies (WICT)	Conf.	1	3.0%

3.5 RQ5. Addressed research areas and topics

The goal of section is to provide a starting point to understand which are the main concepts of Positive Psychology and AIED of the studies. For this analysis, we exclude the terms: article, research, internet, human experiment, behavioral research. We employed humans as synonymous of human; and the elearning systems was the synonymous of educational systems, learning systems, educational environment, learning environments, e-learning environment, virtual elearning systems.

In the Figures 8, 10 and 9 are presented the **co-occurrence analysis** of keywords. The diameter of nodes is proportional to the frequency of each keyword and the thickness of the lines connecting keywords represents the strength of their relationship. Based on the analysis of the aims and scope of the main publication venue to P-AIED, the International Journal of Ar-

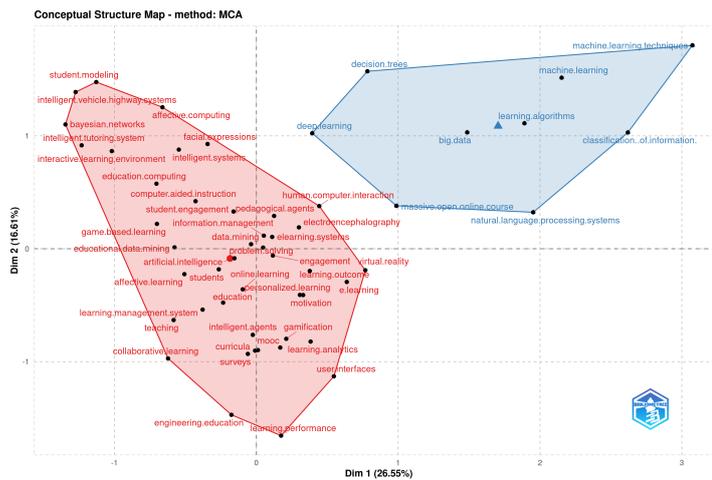


Fig. 13 Clustering map (multiple correspondence analysis) of keywords plus in the field of artificial intelligence using positive psychology.

confirmed with the cluster that emerged from Figure 11 regarding P-AIED. Some emerging areas regarding P-AIED are gamification, Learning Analytics and the use of neuroscientific methods for collecting data.

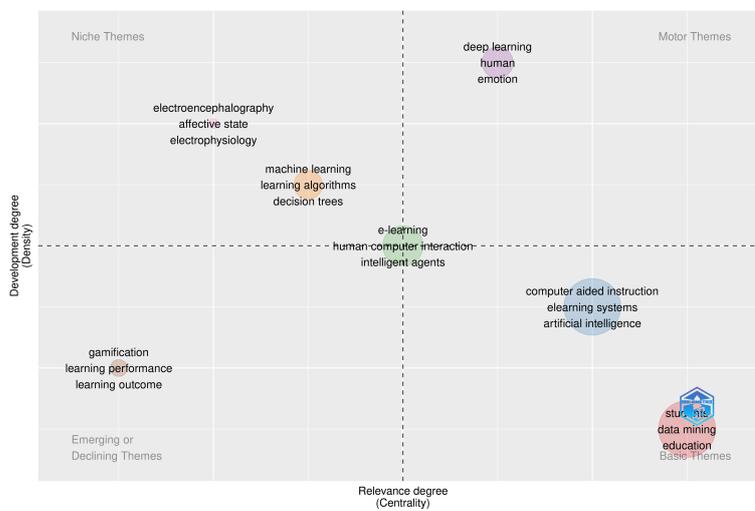


Fig. 14 Thematic map showing relevance and development of topics in P-AIED.

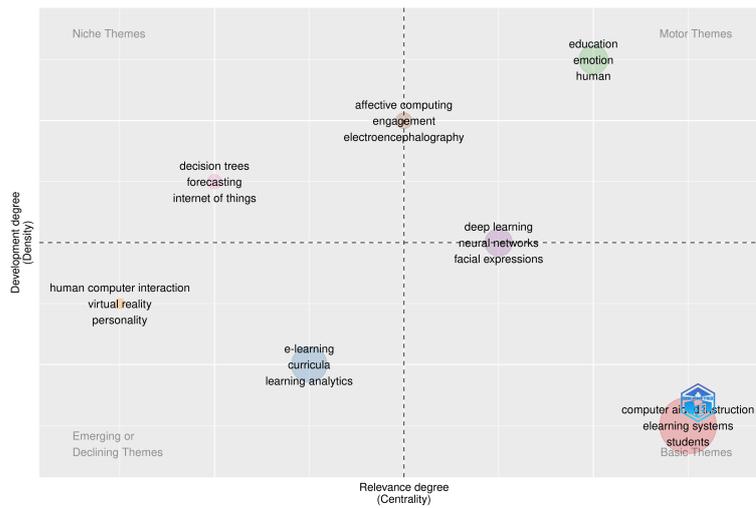


Fig. 15 Thematic map showing relevance and development of topics in positive psychology using artificial intelligence.

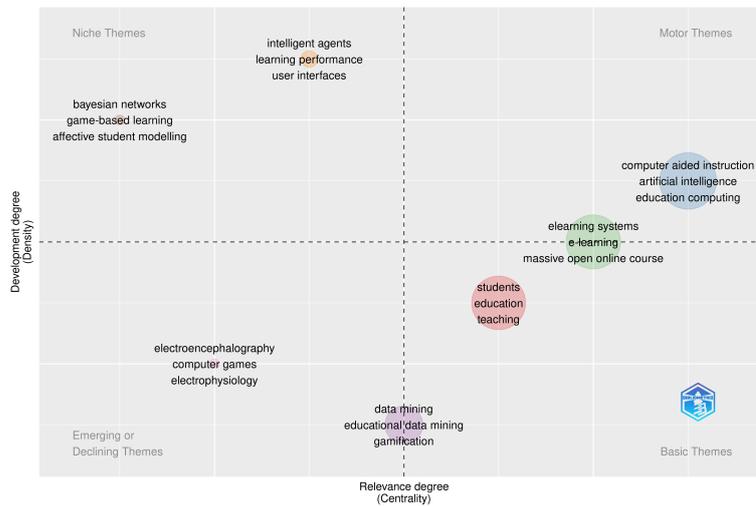


Fig. 16 Thematic map showing relevance and development of topics in artificial intelligence using positive psychology.

3.6 RQ6: Most involved scientific institutions

In response to research question 6 regarding the most involved scientific institutions, 333 institutions were identified with papers published on P-AIED. Figure 17 shows that the most 15 relevant scientific institutions are from the United States, China, United Kingdom and Iran. Additionally, the top

5 universities are also from the United States and the North Carolina State University is far more productive than the others, with 19 studies (7.42%).

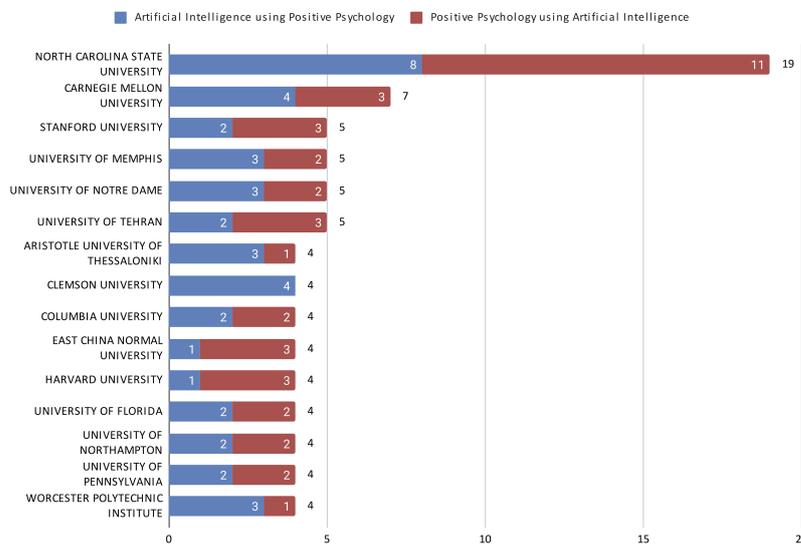


Fig. 17 Most frequent affiliations of publication authors.

3.7 RQ7: Research Leaders

Regarding the research leaders of P-AIED, Figures 18, 20 and 19 present the list of the leaders. Each graphic indicates the researcher, range of publications throughout the years, and number of articles and citations. According to the figures aforementioned, James Lester, Ryan Baker, Roger Azevedo and Sydney D'Mello are the most prolific researcher. Regarding the field of P-AIED (described on Figure 18), the studies vary from 2007 to 2021, however, most of the publications are from 2011 until 2021. Additionally, it is also possible to observe some prominent researchers with publications in the last 5 years, such as R. Kizilcec, Y. Liang, M. Barros-Estrada, and J. Boticario.

Regarding the studies about Positive Psychology using AIED (see Figure 19), the studies also vary from 2007 until 2021, with some prominent researchers with publications in the last 5 years in the topic, such as: Y. Liang, J. Boticario, S. Des, M. Dewan, A. Emerson, and R. Kizilcec. Finally, regarding Artificial Intelligence applied on Positive Education, the studies are from 2010 until 2020 and the most prominent researchers are M Barros-Estrada, R. Zatarain-Cabada, G. Alor-Hernandez, H. Amado-Salvatierra, M. Goswami, N. Heffernan, and G. Hwang.

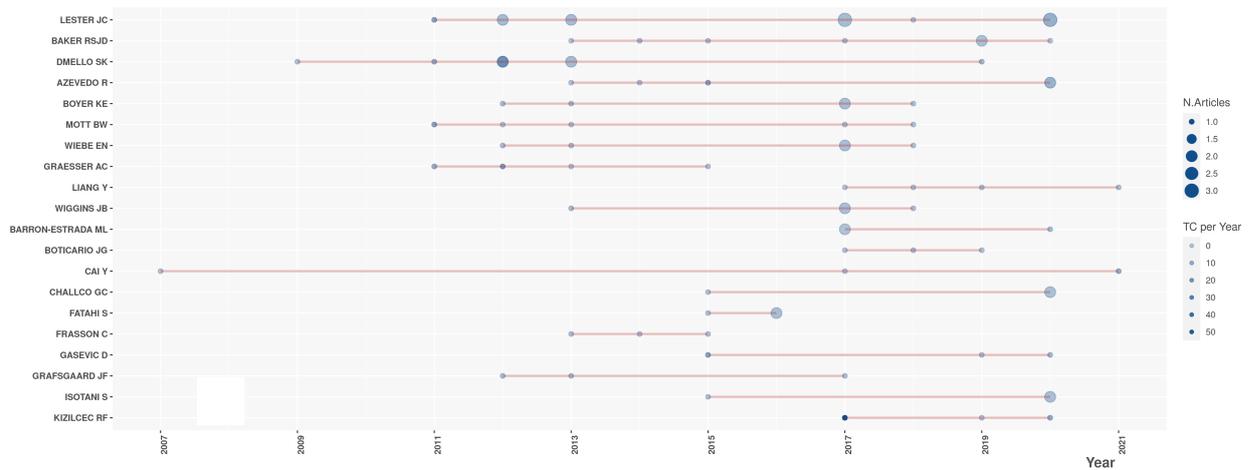
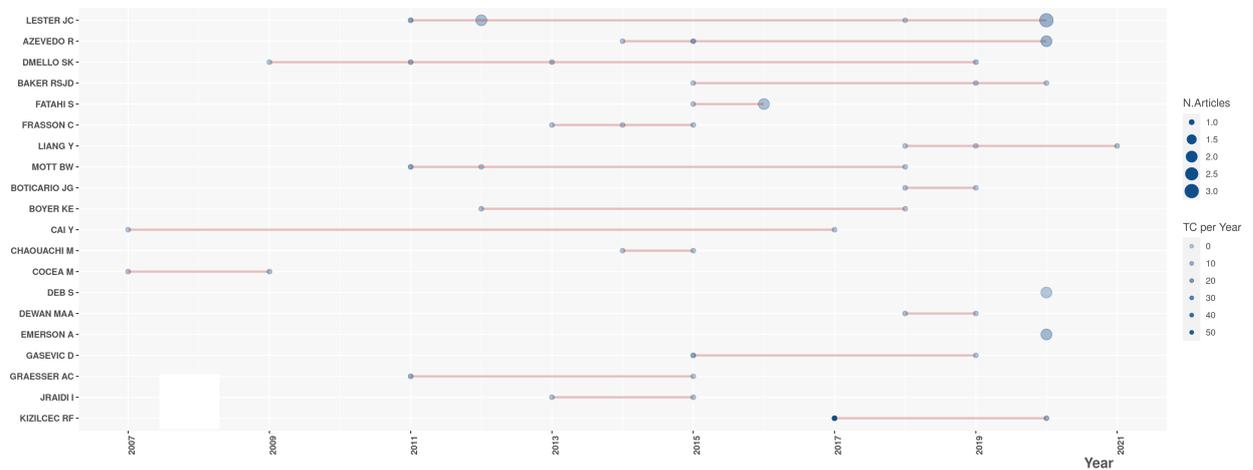


Fig. 18 Most prolific authors in P-AIED per years.



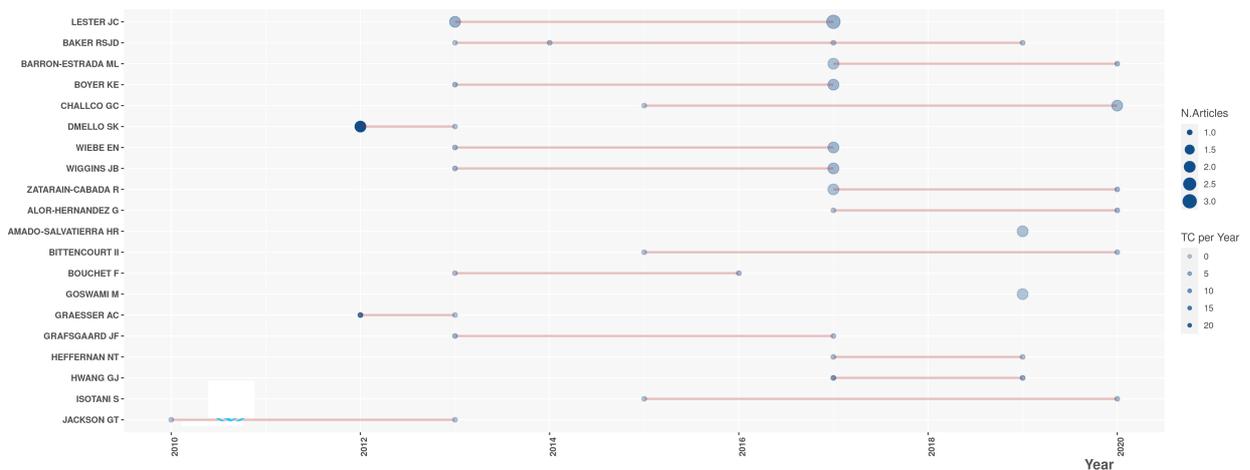


Fig. 20 Most prolific authors in Artificial Intelligence using Positive Psychology per years.

Nevertheless, new clusters can also be identified. By considering collaboration of three or more researchers, there are 11 collaborations ongoing.

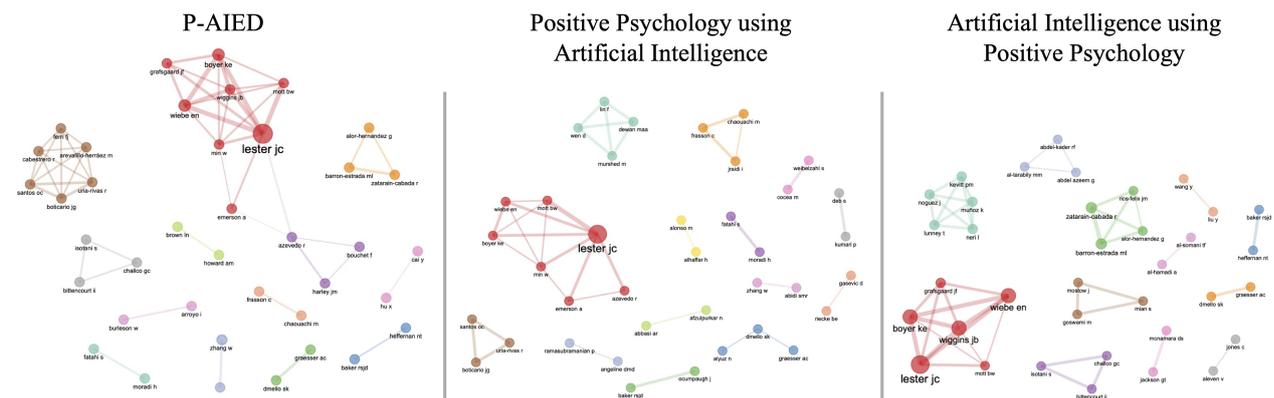


Fig. 21 Map of author collaborations.

Regarding collaboration among institutions, Figure 22 presents such a map. It is interesting to observe that there are several strong collaborations, but all of them involve at least one US university. The universities leading collaborations among the field are North Carolina State University, Carnegie Mellon University, Worcester Polytechnic Institute, and University of Notre Dame.

Finally, Figure 23 indicates multi-country collaboration on P-AIED, Artificial intelligence using Positive Education and Positive Psychology using AIED. It is worth mentioning that there are several multi-continental collaborations

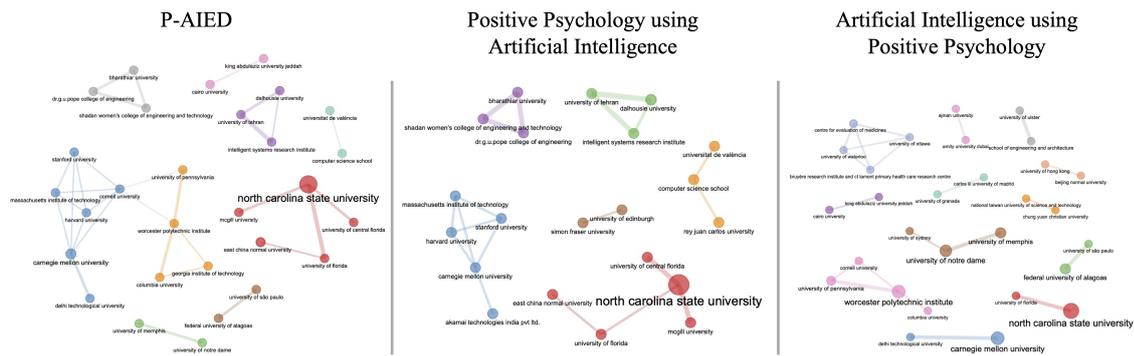


Fig. 22 Map of institution collaboration.

between: American Continent, Asian, and Europe; American Continent and Europe; Europe, American Continent and Africa; Europe and Africa; Asian and Africa; and Europe and Asian.

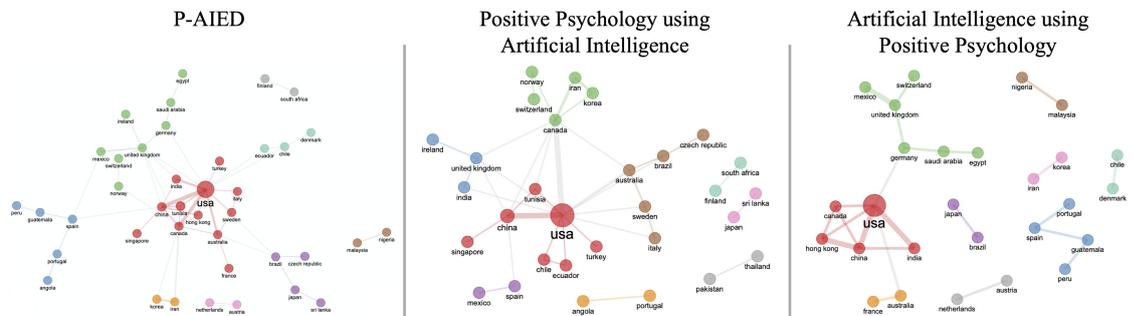


Fig. 23 Map of countries collaboration.

3.9 RQ9: Research Impact

In response to research question about impact, Figure 24 presents the list of the most cited studies. It is possible to observe that four studies has more than 100 citations and they are published on journals. INdeed, only one of the the most cited studies is not a journal paper, which indicates how journal publications are more impactful than book chapters and conference papers.

Regarding the map of co-citations, Figure 25 presents such an information. It is interesting to observe that one of the fathers of positive Psychology, M. Csikszentmihalyi, has an study identified on P-AIED and Artificial Intelligence using Positive Education.

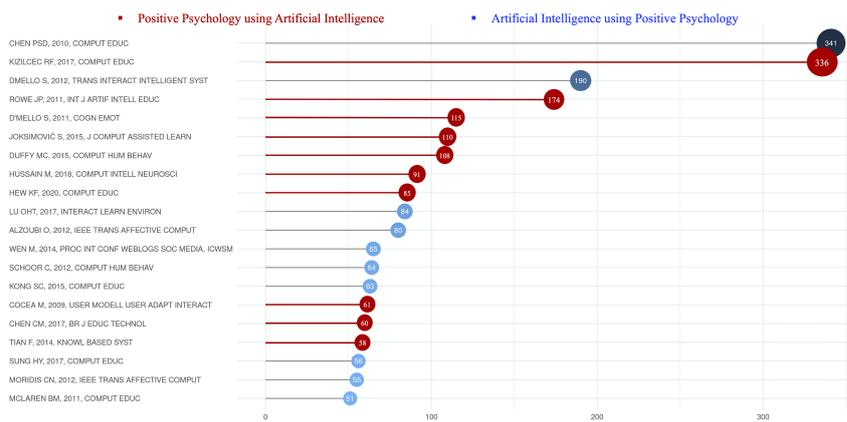


Fig. 24 Most cited works on P-AIED.

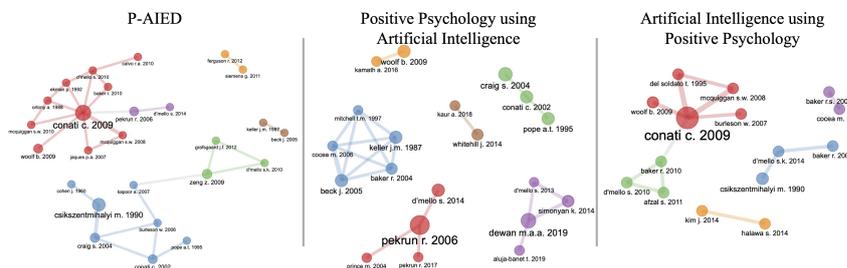


Fig. 25 Map of co-citations.

3.10 Threats to validity

This section describes concerns that must be improved in future replications of this study and other aspects that must be taken into account to generalize the results of the bibliometric analysis performed in this work. In order to organize this section, the threats to validity were classified using the Internal, External, Construct and Conclusion categories (Wohlin et al., 2012).

The main constructs in this review are the two concepts “Artificial Intelligence in Education” and “Positive Psychology”. For the first concept, we used terms of well-cited and well-known secondary and systematic studies published on IJAIED, such as [REF]. For the second concept, we considered the construct PERMA, proposed by one of the fathers of Positive Psychology, Martin Seligman as well as terms from the branch of Positive Psychology, so-called as Positive Education. Additionally, important constructs for each part of PERMA was took into consideration as well. For example, for the P = Positive Emotion, the list of emotions proposed by Barbara Fredrickson [REF] were added. However, the list of terms added was not exhaustive and some terms used on the string returned hundreds of thousands of papers and we had to remove them.

As threats to the internal validity, some subjective decisions may have occurred during paper selection since some primary studies did not provide a clear description or proper objectives and results, making difficult the objective application of the inclusion/exclusion criteria. In order to minimize selection mistakes, the selection process was performed in an iterative way; the data extraction was realized collaboratively by reviewers, and any conflicts were discussed and resolved by all the authors. In this way, we tried to mitigate the threats due to personal bias on study understanding. Moreover, the remaining authors are researchers with expertise in Artificial Intelligence in Education and Positive Psychology. Finally, we had no threat regarding data extraction because it was extracted based on automatic extraction of bibliometric information with the use of a bibliometric tool.

External validity is concerned with establishing the generalizability of the results, which is related to the degree to which the primary studies are representative for the review topic. In order to mitigate external threats, the search process described in Section 2.3 was defined after several trial searches and validated with the consensus of authors. We tested the coverage and representativeness of retrieved studies, including automatic database search and references scan.

With regards conclusion validity, it is possible that some excluded studies in this review should have been included. To mitigate this threat, the selection process and the inclusion and exclusion criteria were carefully designed and discussed by authors to minimize the risk of exclusion of relevant studies. Furthermore, in the final round of study selection, reviewers conducted the selection process in parallel and independently, and then harmonized their selection results to mitigate the personal bias in study selection caused by individual reviewers. As mentioned in Section ??, for the best of our knowledge, there is currently no systematic study regarding AIED and Positive Psychology. Since there was no systematic study, we did not define a time of the published studies included in this bibliometric analysis.

4 Conclusions

In this work, we conducted a bibliometric analysis to investigate the use of authoring tools to design ITS for non-programmer authors. Our goal was to shed the light on the importance of wellbeing and Positive Psychology in the context of Artificial Intelligence in Education. Since there is no systematization on the studies regarding Positive Education (or Positive Psychology) and Artificial Intelligence in Education, we conducted such a bibliometric analysis as the starting point on P-AIED.

Additionally, we coined the concept of Positive Artificial Intelligence in Education (P-AIED). From an epistemological viewpoint, P-AIED concerns with the application of AI to Education to promote both learning and wellbeing, with twofold goals: firstly, research on how AI can be applied to develop individual strengths and personal motivation to promote learning; secondly,

research on how positive education can be applied on the design, development, innovation and transformation of intelligence systems to promote wellbeing in educational settings. In these kind of study, it is investigated, for example, how theories like flow-theory based gamification design could improve knowledge acquisition and promote the well-being of students at the same time.

Two hundred and fifty-six studies out of 10,777 papers were finally included, in which four main ITS components, six ITS types been designed, nineteen features which are facilitating authoring process, three main groups of technologies for developing authoring tools, three main time frames when authoring tool takes place and seven metrics investigated by fifteen empirical studies.

The results presented in this bibliometric analysis can be useful to the artificial intelligence in education community as well as positive education community, since it gathers relevant information from the primary studies included in the review, forming a recent body of knowledge regarding P-AIED. As future work, we intend to further investigate some the possible emerging subfield of AIED community.

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5 Appendix A: publication sources

Table 4 Distribution of studies per countries.

Country	Freq	Pct	PP-AI	AI-PP
USA	152	30.10	81 (53.29%)	71 (46.71%)
CHINA	67	13.27	45 (67.16%)	22 (32.84%)
INDIA	39	7.72	21 (53.85%)	18 (46.15%)
CANADA	32	6.34	16 (50%)	16 (50%)
SPAIN	22	4.36	10 (45.45%)	12 (54.55%)
UK	20	3.96	8 (40%)	12 (60%)
GREECE	13	2.57	5 (38.46%)	8 (61.54%)
MEXICO	13	2.57	4 (30.77%)	9 (69.23%)
BRAZIL	12	2.38	4 (33.33%)	8 (66.67%)
AUSTRALIA	8	1.58	4 (50%)	4 (50%)
EGYPT	8	1.58	4 (50%)	4 (50%)
IRELAND	8	1.58	7 (87.5%)	1 (12.5%)
SAUDI ARABIA	8	1.58	2 (25%)	6 (75%)
GERMANY	7	1.39	2 (28.57%)	5 (71.43%)
PORTUGAL	7	1.39	6 (85.71%)	1 (14.29%)
SOUTH KOREA	7	1.39	5 (71.43%)	2 (28.57%)
FRANCE	5	0.99	2 (40%)	3 (60%)
IRAN	5	0.99	3 (60%)	2 (40%)
ITALY	5	0.99	3 (60%)	2 (40%)
JAPAN	5	0.99	3 (60%)	2 (40%)
SWEDEN	5	0.99	5 (100%)	
INDONESIA	4	0.79	3 (75%)	1 (25%)
SINGAPORE	4	0.79	2 (50%)	2 (50%)
TURKEY	4	0.79	3 (75%)	1 (25%)
GUATEMALA	3	0.59		3 (100%)
MALAYSIA	3	0.59		3 (100%)
NETHERLANDS	3	0.59	1 (33.33%)	2 (66.67%)
NORWAY	3	0.59	3 (100%)	
SOUTH AFRICA	3	0.59	1 (33.33%)	2 (66.67%)
ARGENTINA	2	0.40	2 (100%)	(0%)
CHILE	2	0.40	1 (50%)	1 (50%)
CZECH REPUBLIC	2	0.40	1 (50%)	1 (50%)
KUWAIT	2	0.40	2 (100%)	
MOROCCO	2	0.40	2 (100%)	
PAKISTAN	2	0.40	2 (100%)	
PHILIPPINES	2	0.40	1 (50%)	1 (50%)
SWITZERLAND	2	0.40	1 (50%)	1 (50%)
TUNISIA	2	0.40	1 (50%)	1 (50%)
ANGOLA	1	0.20	1 (100%)	(0%)
AUSTRIA	1	0.20		1 (100%)
BAHRAIN	1	0.20		1 (100%)
BELGIUM	1	0.20		1 (100%)
DENMARK	1	0.20		1 (100%)
ECUADOR	1	0.20	1 (100%)	
FINLAND	1	0.20	1 (100%)	
NIGERIA	1	0.20		1 (100%)
PERU	1	0.20		1 (100%)
QATAR	1	0.20		1 (100%)
SRI LANKA	1	0.20	1 (100%)	
THAILAND	1	0.20	1 (100%)	

PP-AI: Positive Psychology using Artificial Intelligence
AI-PP: Artificial Intelligence using Positive Psychology