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Pedagogical Practice Mediated Adaptive Educational by Emerging Didactics, Technologies, and Affective Informatics in Higher Education: A Systematic Review

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Abstract

Higher education in order to achieve comprehensive training in students must take advantage of the potential offered by educational technologies to successfully meet the challenges of the digital age. Consequently, the objective of this article is to analyze the implications of pedagogical practice and emerging didactics mediated by adaptive educational technologies and affective computing for the training of students in the context of university education, for which a systematic review and meta-analysis was carried out applying by using the PRISMA methodology, a documentary analysis which includes 124 scientific articles indexed in Scopus, WoS, SCIELO, Google Scholar for the years 2018-2023 was developed, whose methodological quality was evaluated using the CASP scale, giving as a final result 87 articles to which applied a bibliometric analysis using RStudio based on the keywords emerging didactics, pedagogical practice, adaptive educational technology, comprehensive training and affective computing. We worked under a mixed approach, with a qualitative perspective of a descriptive documentary nature that combines a theoretical-documentary-bibliographical analysis design, as well as a quantitative perspective derived from statistical data. The results explain the techno-pedagogical articulation helps to transform the pedagogical practice and leads to the integral formation of the students. The effectiveness of the use of educational technologies and emerging didactics in the pedagogical practice of teachers, the comprehensive training of students and the quality of university education in the digital society are concluded.

Keywords: *adaptive educational technologies, pedagogical practice, didactics, affective computing, higher education, Prisma*

1. Introduction

Educational technologies are changing the way of teaching and learning at different educational levels, requiring the educational system to fit into the new times, taking advantage of its potential to strengthen the teaching-learning process and achieve critical and reflective students capable of facing the challenges of the world of work (Aguiar, Velázquez and Aguiar, 2019). In this context, it is important to analyze: how educational technologies can be used in the pedagogical practice of teachers to achieve the comprehensive training of students in higher education?

Based on the above, this systematic review article carries out a meta-analysis to examine how educational technologies have an impact in pedagogical practice and its implication in the

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comprehensive training of students in higher education. The PRISMA methodology was applied for the emerging didactic categories, adaptive educational technologies, affective computing, pedagogical practice and comprehensive training in higher education.

The reviewed scientific articles deal in depth with the implications of ICT and specifically of Adaptive Educational Technologies (TEA) in educational processes, the systemic levels of integration of teachers, institutions and educational policies, the characteristics and factors that affect the responsibilities of the changes caused by the educational use of ICT, as well as various perspectives that must be considered in an integrated and complementary way to achieve quality education and finally, address the implications of emerging didactics, adaptive educational technology, pedagogical practice , informatics or affective computing and comprehensive training. With respect to informatics or computing, this is considered as a field of informatics focused on the development of systems and technologies that can detect, interpret and respond to human emotions. In the field of higher education, affective computing aims to improve the learning experience of students through the use of technologies that can detect and respond to students' emotions (Wang, Chen, Liang, 2019; Elgohary and Al-Dossary, 2022; Barakina, Popova, Gorokhova, and Voskovskaya, 2021).

In this same line, other studies raise the need in order to include technology as a transversal axis in the curriculum that leads to a scientific-technological training (González Martínez, 2021), considering that programs must be created to train teachers in effective inclusion. of transversal themes and technologies in the curriculum to ensure learning and the development of generic and specific competencies of the students, in the same way they emphasize that creativity and innovation must be encouraged in the teaching-learning process at all educational levels, especially in higher education. (A'mar and Eleyan, 2022; Arteaga, Gravini-Donado and Riva, 2021; Moreno-Pino, Jiménez-Fontana, Cardeñoso Domingo and Azcárate Goded, 2021; Moreno-Pino, Jiménez-Fontana, Domingo, Goded, 2022; Muukkonen , Lakkala, Ilomäki and Toom, 2022).

Together, these dimensions make it possible to adapt the teaching and learning process to the individual needs and characteristics of each student, which leads to improving the quality of learning, increasing the motivation and commitment of students in their university education process. (Pando, 2018; Ahammad, Chakraborty, Akter, Fomey, & Rahman, 2021; Renz & Hilbig, 2020; Luckin & Cukurova, 2019).

Likewise, the review of the Emerging Didactics category, allowed to identify the reality and didactic trends in higher education, suggesting the training of university professors in active methodologies, educational technology, formative evaluation for the development of competences and digital didactics. , universal and intercultural in courses; Likewise, the use of mobile applications, simulations, and games to improve student motivation and performance and to understand and retain concepts (Moreno-Pino, Jiménez-Fontana, Cardeñoso Domingo, and Azcárate Goded, 2021 ; Moreno-Pino, Jiménez-Fontana, Domingo and Goded, 2022; Areskoug Josefsson, Haarr, Eriksen and Brossard Børhaug, 2022).

In the field of pedagogical practice, the systematic review has a conceptual framework for the design of pedagogical approaches focused on collaborative learning mediated by the use of digital resources, stating these serve as a reference point for both collaborative learning and for creation and transfer of knowledge. The authors agree that the development of generic skills, such as communication and problem solving, can be supported by pedagogical approaches that emphasize collaboration and active learning; In the same way, they consider that mobile learning becomes an effective tool for active

learning, collaboration, personalization of learning and the development of digital literacy skills (Damsa and Muukkonen, 2020; Muukkonen, Lakkala, Ilomäki and Toomo, 2022 ; Nagovitsyn, Bartosh, Ratsimor, & Neverova, 2019; Bai, 2019; Delgado Martínez, 2019; Garcia Carmona, 2020; Firestone, Aramburo y Cruz, 2021).

Other researchers analyze students' interactions with mobile technology and their participation in science learning activities, studying students' perceptions of massive open online courses (MOOCs) during the COVID-19 pandemic, suggesting that MOOCs they have the potential to provide flexible and accessible learning opportunities. They suggest that effective use of technology can enhance students' social and cognitive presence in online learning. use research community theory and technology acceptance to explore the impact of the online learning environment, teacher presence, and social presence on student motivation. (Wang, Li and Zhao, 2021; Anand Shankar Raja, Kallarakal, 2021; Zhan et al., 2022; Zuo et al., 2022; Vega-Rodríguez, Botero-Suaza, 2020; Orozco-García, Vasquez-Rizo, Ealabán-Coello , 2020).

Following the systematic review, there are other studies that highlight the incidence of adaptive learning in student learning; whose results show that when they used the adaptive learning environment, they showed a greater commitment to learning, a greater satisfaction with the learning process and the improvement of the academic performance of the students (El-Sabagh, 2021). As regard, other authors analyze the impact of online learning platforms on student learning outcomes and suggest that the effective use of ICT can improve access to quality education. quality, and analyze the effects of adaptive learning, gamification on learning, motivation and engagement in higher education, concluding that adaptive learning and gamification can be effective strategies to improve teaching and learning outcomes (Kerimbayev et al., 2020; De la Cruz, Macías, Viejó and Chisag, 2020; Bosquez, et.al., 2018; Arias, Tomaselli and Tortosa, 2021).

On the other hand, it is worth considering relevant aspects found in the Affective Informatics category in higher education, the findings show that this category must be analyzed from various points of view, such as the use of virtual learning environments, didactic mediation tools, the restructuring of content and skills to provide meaning and real meaning to school instruction and integral human formation. (Muukkonen, Lakkala, Ilomäki and Toom, 2022). Some of the scientific studies see affective computing as a branch of Artificial Intelligence that seeks to interpret human emotions to improve the interaction between people and machines (Guidetti, 2019; Loepp, Donkers, Kleemann, & Ziegler, 2019; Chen et al., 2021).

On the other hand, Martínez, Mendigaña and Zapata (2021). These articles offer an overview of the challenges and recommendations to implement a comprehensive training in higher education and emphasize the importance of students developing critical and reflective skills to become engaged citizens capable of facing the challenges of today's world.

In this framework, the role that this type of skills should play in current education is highlighted on the socio-emotional skills of students. Aspects that challenge to review the curricular designs that guide the training of the teaching staff to identify contributions capable of impacting the development of their ability. (Aristulle and Paoloni-Stente, 2019). The authors conclude that steps should be taken to improve students' emotional intelligence and encourage social interaction in online learning. They highlight the importance of continuous training of tutors to improve the quality of education and the need for an evaluation model that allows measuring their effectiveness in teaching, they conclude that this model can be useful to improve tutor

training and quality. of higher education in general. (Macias-Esparza, Canedo-Ortiz, Eudave-Munoz and Paez, 2018; Alenezi, 2020).

2. Method

The systematic review and meta-analysis were carried out by using the PRISMA methodology for the categories: emerging didactics, adaptive educational technologies, affective computing, pedagogical practice and comprehensive training in higher education. We worked under a mixed approach, initially from a qualitative perspective of documentary nature of an exploratory-descriptive type that combines a theoretical-documentary-bibliographical analysis design, later a quantitative analysis derived from derived statistical data.

First of all, the research question was drafted: What are the most effective pedagogical practices in higher education that use adaptive educational technology, emerging didactics and affective computing for the integral formation of students? In order to answer the silver problem question, it was necessary to systematically check, synthesize and analyze the existing scientific literature in order to get a deeper understanding of the issues related to teaching and learning in the context of innovative technologies and methodologies with the aim of in order to obtain useful and relevant information that helps teachers and decision makers to improve the quality of education offered in the digital society.

Secondly, we proceeded to identify the relevant scientific studies through the search for keywords, which resulted in an initial set of 124 article manuscripts Scopus, Web of Science, SCIELO, Google Scholar of extracted data with inclusion criteria. being within an observation window of 2018-2023. The 124 articles found were subjected to a methodological quality evaluation process with the scale, following the following steps: the article was read, where its design, objectives and results were analyzed, as well as the validity of the evidence presented in the study , taking into account whether the data was accurate, reliable and relevant, the importance and relevance of the evidence in relation to the topic of interest in teaching and learning. In order to achieve the aforementioned, for each article, 11 questions suggested by the CASP scale were answered, then the systematic and organized extraction of data was carried out using the extraction criteria of the methodology.

Next, a meta-analysis of the 87 resulting articles was carried out through a bibliometric analysis carried out with the RStudio software for each of the five specific categories educational technologies, affective computing, emerging didactics, pedagogical practice and comprehensive training defined in the project, highlighting for each article the most relevant authors, authors who have the largest number of annual publications, the most cited authors, scientific production by country and by each . In addition to these articles, 23 remaining articles were selected that are not indexed in Wos and Scopus and that were included in the systematic review for their contribution to the research study, the quartile of the journal and the respective citations were reviewed.

3. Results and Findings Carried Out Through the Bibliometric Analysis for Each Category

According to the results obtained from the 87 articles indexed in the WoS and SCOPUS databases, an exhaustive bibliometric analysis was done in the four specified categories within

the field of higher education. These selected categories are: (1) emerging didactics, which addresses innovative methodologies and approaches in teaching and learning; (2) pedagogical practice, which focuses on the study of strategies and techniques applied by teachers in the classroom to improve the quality of education; (3) educational and adaptive technologies, which test the implementation and impact of technological tools in the educational process, as well as solutions that allow the personalization of learning through Artificial Intelligence; and (4) comprehensive training.

3.1 Results and Findings of Each Category of Analysis

3.1.1 Emergent Didactics

Table 1 shows the authors with the largest number of annual publications in the category of Emerging Didactics. It is important to note that some authors appear with zero, which implies that their works are recently published. However, these contributions are considered of great relevance and value for research on this topic.

Table 1: Annual Publications in the Emerging Didactic Category Deduced from the Wos Database.

Title and author	Emerging constructs	Citations
Gamification and mobile learning: innovative experiences to motivate and optimise music content within university contexts. (Carrión Candel y Colmenero, 2022).	Active learning, mobile learning, project-based learning, formative assessment, gamification techniques in higher education	2
Study of the presence of sustainability competencies in teacher training in mathematics education. (Moreno-Pino, Jiménez-Fontana, Cardeñoso Domingo y Azcárate Goded,2021).	Importance of integrating sustainability into the curriculum, Critical thought, Innovation and creativity, Collaboration and communication Social commitment	5
The use of video games and gamification as innovative teaching material for learning social sciences in higher education. (Carrion Candel E, 2022).	Motivation, active learning, collaboration, critical thought and immersion.	3
Training in mathematics education from a sustainability perspective: a case study of university teachers' views. (Moreno-Pino, Jiménez-Fontana, Domingo y Goded, 2022).	Teacher training in higher education, curriculum for sustainability, critical thought, sustainable development through education.	1

Source: Wos Database.
Note: This table presents the authors, emerging constructs and their respective citations in the Wos database for the didactic category.

Likewise, Table 2 presents the on the topic most cited authors of Emerging Didactics during the last five years, together with their respective publications, deduced from the SCOPUS database.

Table 2. The Most Cited Topic in Emerging Didactics Category by Author During the Last Five Years Deduced from The SCOPUS Database.

Papers	Emerging constructs	Citations
Digital literacy and digital didactics as the Basis for new learning models development (Liu, Tretyakova, Fedorov, Kharakhordina,2020).	Digital literacy, Digital didactics, Digital competence, Mobile learning Project-based learning, Collaborative learning, Virtual learning environments	18
Didactic trends in virtual education: An interpretive approach (Pando, 2018).	Virtual education, didactic trends. Interpretive approach, personalized learning, gamification, mobile learning, virtual and augmented reality.	14
Effect of stereoscopic anaglyphic 3-dimensional video didactics on learning neuroanatomy (Goodarzi, Monti, Lee, & Girgis, 2017).	Didactic video, 3D content, Visual learning, Problem-based learning, Educational technology.	11
La investigación en Didáctica de las Ciencias Sociales en revistas españolas de Ciencias de la Educación. Un análisis bibliométrico (2007-2017) (Gómez Carrasco, López Facal,y Rodríguez Medina, 2019).	Didactics of Social Sciences, Research in education, Educational Sciences, Bibliometric analysis, Internationalization of research	10
Learning Design for Future Higher Education–Insights From the Time of COVID-19. Covid-19 and beyond: From (forced) remote teaching and learning to 'the new normal'in higher education (Scherman, Islam, Dikaya, Dumulescu, Pop-Păcurar & Necula, 2023).	Educational technology, Learning design, Higher education, COVID-19, Distance teaching and learning, New teaching models	9
Vorbereitung angehender Sportlehrkräfte auf einen inklusiven Sportunterricht? Eine kritische Bestandsaufnahme hochschuldidaktischer Lehrformate (Erhorn, , Möller & Langer, 2020).	Inclusion, teaching and learning in higher education, course design by teachers, teaching formats used in higher education.	7
Study of the presence of sustainability competencies in teacher training in mathematics education (Moreno-Pino, Jiménez-Fontana, Cardeñoso Domingo, & Azcárate Goded, 2021).	Competences, Sustainability, Teacher training, Competences in sustainability Competency assessment	5
DidacticsRevolution: Applying Kotter's 8-Step Change Management Model to Residency Didactics (Haas, Munzer, , Santen, Hopson, Haas, , Overbeek, & Huang,2020).	Didactics of the pedagogical residence, Educational Innovation, Resistance to change Leadership, Communication	5
Hudson, B. (2019). Epistemic quality for equitable access to quality education in school mathematics.	Epistemic quality, equitable access to quality education, social justice, curriculum design, pedagogical practices, teacher training, action-based research	4
Palazón-Herrera, J., & Soria-Vílchez, A. (2021). Students' perception and academic performance in a flipped classroom model within Early Childhood Education.	Flipped classroom model, Academic performance, Student perception, Teaching-learning, Educational evaluation, Didactic strategies.	3
Learner-centred learning tasks in higher education: A study on perception among students (Li, 2021).	Student-centered learning, learning tasks in higher education, Student perception, Teaching and learning, Educational innovation	3
Didactic experience for the teaching of contemporary history through sources in Higher Education. Panta Rei (Llonch-Molina & Parisi-Moreno, 2018).	Didactic experience, Meaningful learning	3
Higher education journals as didactic frameworks (Keiding, Qvortrup, 2018).	Didactics, Didactic Framework, Teaching and learning in higher education, Academic communication Academic competences.	6
Hybrid solutions for didactics in higher education: An interdisciplinary workshop of 'Visual Storytelling'to develop documentation competences (De Rossi, Restiglian, 2019).	Hybrid solutions for didactics in higher education, Interdisciplinary workshop, Documentation skills, Active learning, Interdisciplinary approach	7

Source: SCOPUS Database.

Note: This Table Presents the Topic Most Cited by Authors in Emerging Didactics Category.

Figure 1 shows the scientific production connected to the category of Emerging Didactics by country, highlighting Spain as one of the countries with the highest productivity in this field of research.

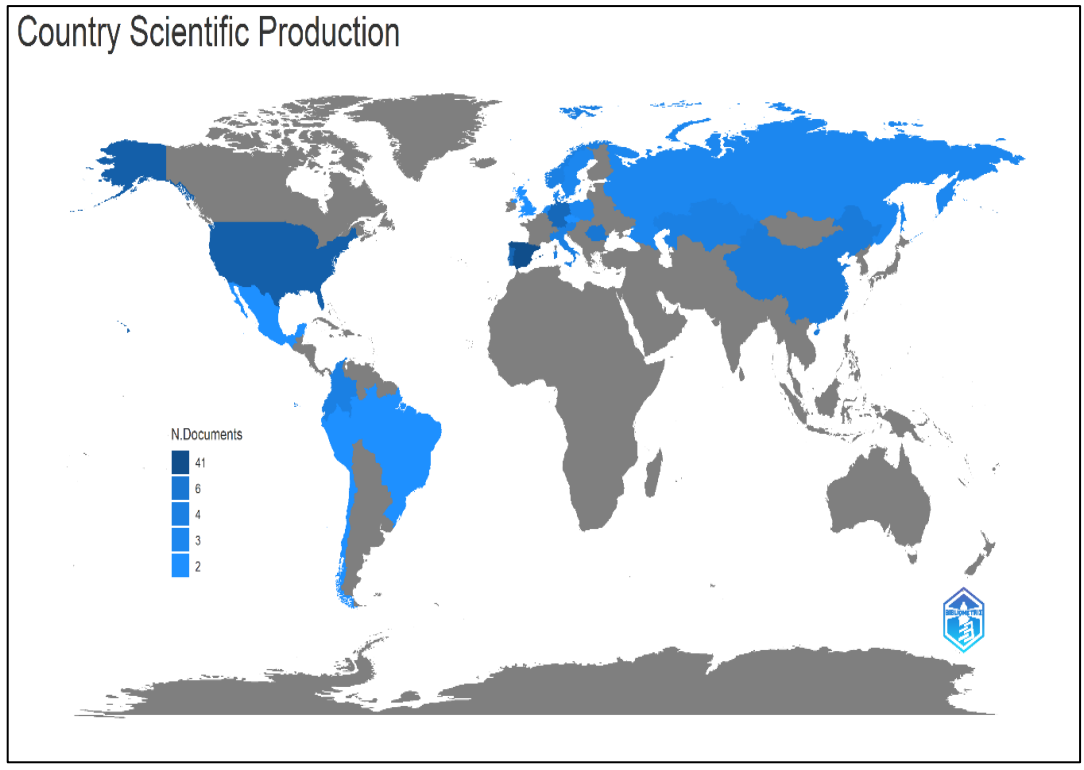

Fig. 1. Scientific Production by Country in the Emerging Didactic Category.
Source: Result of the Bibliometric Analysis.

3.1.2 Emerging Didactic Category Findings

The systematic review and meta-analyses carried out on the emerging didactic category yielded several important findings. First, the authors discuss the importance of adequate didactic training for higher education teachers, with the aim of improving the quality of teaching. This training must include digital literacy and didactics, as a basis for the development of new learning models.

On the other hand, it was found that the emerging didactic trends in higher education are focused on gamification, video games and mobile learning, as techniques that motivate students to improve their learning experience. In addition, it is highlighted that the use of the inverted classroom model, universal and intercultural digital didactics, the interpretive approach of didactic trends in virtual education and other teaching methods can improve the academic performance of students.

3.1.3 Pedagogical Practice

Table 3 shows the authors with the largest number of annual publications in the category of Pedagogical Practice. It is important to note that some authors appear with zero, which implies that their works are recently published. However, these contributions are considered of great relevance and value for research on this topic.

Table 3. Authors with More Annual Publications in the Pedagogical Practice Category Deduced from the Wos Database.

Title and author	Emerging constructs	Citations
Damsa, y Muukkonen (2020).	Pedagogical designs Collaborative learning, Learning Object, Instructional Design, Educational Technology:	4
McCowan, Omingo, Schendel, Adu-Yeboah y Tabulawa (2022).	Pedagogical change, Enabling factors, Academic leadership, Teacher professional development.	1
Nagovitsyn, Bartosh, Ratsimor y Neverova (2019).	Continuing pedagogical educational system model, Region, modernization, Motivation. Pedagogical competences.	19
Bai (2019).	Mobile learning, Pedagogy, Design of learning activities, Digital competences Learning assessment, Collaboration and communities of practice.	17
McMinn,Dickson & Areepattamannil (2022).	Focused teaching centered, STEAM educational approach, Pedagogical approaches.	2
Perera, Zainuddin, Piaw, Cheah y Asirvatham (2020).	Teaching methods, Innovative techno-pedagogical approaches, Blended learning, meaningful and personalized learning experiences	*4*

Source: Wos Database.

Note: This Table Presents the Authors with More Annual Publications in the Pedagogical Practice.

Table 4, it is introduced the most cited authors in the Pedagogical Practice category during the last five years, along with their respective publications.

Tabla 4. Most Cited Topic by Authors in The Pedagogical Practice Category Extracted from The SCOPUS Database.

Papers	Emerging constructs	Citations
Miranda, J., Navarrete, C., Noguez, J., Molina-Espinosa, J. M., Ramírez-Montoya, M. S., Navarro-Tuch, S. A., ... & Molina, A. (2021). The core components of education 4.0 in higher education.	Education 4.0, Educational innovation, Competences, Learning methods, Higher education in engineering.	78
Nagovitsyn, R. S., Bartosh, D. K., Ratsimor, A. Y., & Neverova, N. V. (2019). Modernization of Regional Continuing Pedagogical Education in the «School-College-Institute».	Modernization, Pedagogical Education, Regional Continuation, School-College-Institute.	18
Bai, H. (2019). Pedagogical practices of mobile learning in K-12 and higher education settings.	Pedagogical Practices, Mobile Learning, K-12 Education, Higher Education.	17
Evans, C., Kandiko Howson, C., Forsythe, A., & Edwards, C. (2021). What constitutes high quality higher education pedagogical research?	Pedagogical research in higher education, Quality.	13
Cavanagh, T., Chen, B., Lahcen, R. A. M., & Paradiso, J. R. (2020). Constructing a design framework and pedagogical approach for adaptive learning in higher education: A practitioner's perspective. International.	Adaptive courses, Adaptive learning, Course design, Instructional design, Learning analytics, Mastery of learning, personalized learning.	11
Melnychuk, I., Drozdova, I., Savchak, I., & Bloshchynskyi, I. (2019). Higher School Instructors' Pedagogical Skills Improvement as a Basis of Educational Strategy for Development of Students' Professional Training.	Higher education, Pedagogical skills of instructors, educational strategy, Professional training.	9
Gilbert, A., Tait-McCutcheon, S., & Knewstubb, B. (2021). Innovative teaching in higher education: Teachers' perceptions of support and constraint.	Innovative teaching, Higher education, Teachers' perceptions, Support, Constraint.	9
Mohamad, M. M., Heong, Y. M., Kiong, T. T., Mukhtar, M. I., & Ahmad, A. (2019). Teachers' pedagogical reasoning and action in technical and vocational education.	Technical and vocational education, Pedagogical reasoning of teachers, Pedagogical action of teachers.	6

Papers	Emerging constructs	Citations
Shah, U., Khan, S. H., & Reynolds, M. (2020). Insights into variation in teachers' pedagogical relationship with ICT: A phenomenographic exploration in the Pakistani higher education context.	Pedagogical relationship, ICT (Information and Communication Technologies), Phenomenography, Higher education, educational context	6
Chan, C. K. Y., & Luo, J. (2022). Exploring teacher perceptions of different types of 'feedback practices' in higher education: implications for teacher feedback literacy. Assessment & Evaluation in Higher Education, 47(1), 61-76.	Professors Perceptions, Feedback Practices, Higher Education, Teacher Feedback Literacy	6
Silander, C., & Stigmar, M. (2021). What university teachers need to know-perceptions of course content in higher education pedagogical courses. International	Importance of pedagogical training for university professors, Influence of pedagogy courses on the teaching of teachers.	4
Damsa, C., & Muukkonen, H. (2020). Conceptualising pedagogical designs for learning through object-oriented collaboration in higher education.	Object-oriented collaboration, Pedagogical design, situated learning, Teaching methodologies.	4
Perera, C. J., Zainuddin, Z., Piaw, C. Y., Cheah, K. S., & Asirvatham, D. (2020). The pedagogical frontiers of urban higher education: blended learning and co-lecturing.	Combined teaching, innovative pedagogical approaches in urban higher education.	4
Okolie, U. C., Igwe, P. A., Nwajiuba, C. A., Mlanga, S., Binuomote, M. O., Nwosu, H. E., & Ogbaekirigwe, C. O. (2020). Does PhD qualification improve pedagogical competence? A study on teaching and training in higher education.	Pedagogical competence of university professors, Pedagogical knowledge, teaching and training in higher education	3

Sources: Database SCOPUS

Note: This Table Presents the most Cited Topic by Authors in the Pedagogical Practice Category.

Figure 2 illustrates the scientific production linked to the category of pedagogical practice by country, highlighting the United Kingdom as one of the countries with the highest productivity in this field of research.

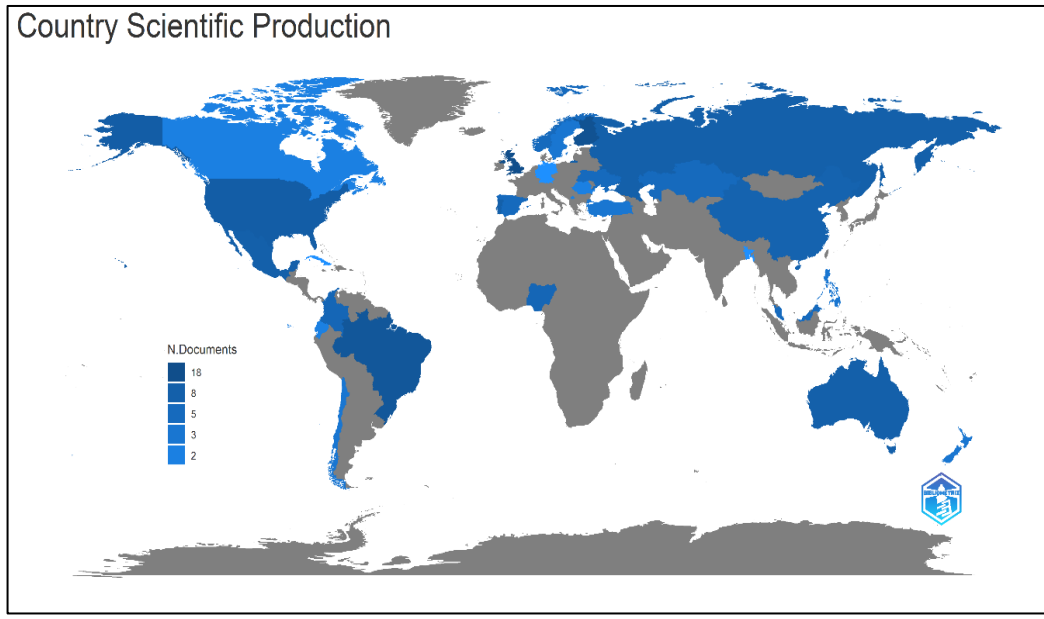

Fig. 2. Scientific Production by Country Linked to the Pedagogical Practice Category.
Source: Bibliometric Analysis.

3.1.4 Findings Category of Pedagogical Practice

The findings of the systematic review of the pedagogical practice category suggest, first of all, it is essential for the authors that teachers plan properly before integrating technology into their pedagogical practice in order to achieve successful teaching, learning, collaboration and interaction of the students. Elements that influence pedagogical change at universities, such as leadership, infrastructure, financing, and institutional culture, are also discussed. In addition, the importance of designing a methodological route product of pedagogical planning is highlighted to be applied in pedagogical practice with didactic strategies, content and evaluation activities that promote the development of both specific and generic skills supported by mobile technology to support and improve learning and teaching.

3.1.5 Adaptive Educational Technologies

The following table exposes the authors with the largest number of annual publications in the Educational and Adaptive Technologies category. It is important to note that some authors appear with anything, which involves their works are recently posted. However, these contributions are considered of great relevance and value for research on this topic.

Table 5. Authors with more Annual Publications in the Category of Adaptive Educational Technologies Extracted from the Wos Database.

Title and author	Emerging constructs	Citations
COVID-19 and students' perception about MOOCs a case of Indian higher educational institutions Students perception about MOOCs. (Anand Shankar Raja, Kallarakal, 2021).	Impact of COVID on education, Student perception of educational technologies, Response of educational systems to the crisis, Relationship of MOOCs with other technologies educational.	5
Artificial intelligence applications in Latin American higher education: a systematic review. (Salas-Pilco y Yang, 2022).	Digital technologies, Artificial intelligence, Interactive technologies, Specific educational applications for cultural heritage, Benefits and limitations of AI in the context of higher education.	6
Continuing to teach in a time of crisis: the chinese rural educational system's response and student satisfaction and social and cognitive presence. (Wang, Yang, Li y van Aalst, 2021).	Adaptation of the educational system to the crisis, Student satisfaction with their learning experience, Social and cognitive presence in online learning.	6
Digital technologies for heritage teaching: trend analysis in new realities. (Arteaga, Gravini-Donado y Riva,2021).)	Effectiveness of digital technologies in teaching cultural heritage, Trend towards the use of these technologies in education, Challenges and opportunities of teaching cultural heritage in the new technological realities.	2
Effect of Principal's Technology Leadership on Teacher's Technology Integration. (A'mar y Eleyan,2022).	Technological leadership, Technology integration in teaching and learning, Influence of school culture and norms on the integration of technology	2
Investigating students' engagement in mobile technology-supported science learning through video-based classroom observation. (Zhan, Sun, Wen, Yang y Zhan, 2022).	Student Engagement in Science Learning, Mobile Technology to Support Science Learning, Mobile Science Learning Environment	0
K-12 students' online learning motivation in China: An integrated model based on community of inquiry and technology acceptance theory. (Zuo, M., Hu, Luo, Ouyang Y Zhang, 2022).	Motivation in online learning, Relationship theory research community, Acceptance of technology by of students influences their motivation for online learning.	9
Robotics in the international educational space: Integration and the experience. Education and Information Technologies, 25, 5835-5851.(Kerimbayev, Beisov , Kovtun, Nurym, Akramova, 2020).	Impact of robotics in education, the effectiveness of robotics in teaching and learning, student experience in the use of robotics in education.	2
The Effectiveness of an Educational Environment Based on Artificial Intelligence Techniques Using Virtual Classrooms on Training Development (Elgohary y Al-Dossary, 2023).	The effectiveness of artificial intelligence techniques in education, the impact of training on skill development	6
Visualization analysis of artificial intelligence technology in higher education based on SSCI and SCI journals from 2009 to 2019. (Wang,y Zhan,2021).	Trends in artificial intelligence research in higher education, Methodological approaches used in research, Application of artificial intelligence in higher education.	4

Source: Wos Database.

Note: This Table Presents the Authors with more Annual Publications in the Category.

Table 6 shows the most cited authors on the subject of Educational and Adaptive Technologies during the last five years, along with their respective publications.

Table 6. Most Cited Topics by Author in the Category Adaptive Educational Technologies Extracted from the SCOPUS Database.

Paper	Emerging construct	Citations
Luckin, R., & Cukurova, M. (2019). Designing educational technologies in the age of AI: A learning sciences-driven approach.	Educational technologies in the age of AI, using the AI to improve education, Design of adaptive educational technologies, Evaluation of educational technologies.	45
Seufert, S., Guggemos, J., & Sailer, M. (2021). Technology-related knowledge, skills, and attitudes of pre-and in-service teachers: The current situation and emerging trends.	Technological knowledge and skills of teachers, Teachers' attitudes towards technology, Mobile learning and the use of AI in education.	36
Renz, A., & Hilbig, R. (2020). Prerequisites for artificial intelligence in further education: identification of drivers, barriers, and business models of educational technology companies.	Requirements for the educational use of artificial intelligence in higher education, Importance of the adoption of artificial intelligence in higher education	30
Prendes Espinosa, M. P., & Cartagena, F. C. (2021). Advanced technologies to face the challenge of educational innovation. *RIED*	Use of advanced technologies to meet the challenge of educational innovation, Facial expression analysis, Emotion detection, virtual learning.	20
Ouherrou, N., Elhammoumi, O., Benmarrakchi, F., & El Kafi, J. (2019). Comparative study on emotions analysis from facial expressions in children with and without learning disabilities in virtual learning environment.	Analysis of expressions, Emotion detection, virtual learning	15
Huang, S. (2021). Design and Development of Educational Robot Teaching Resources Using Artificial Intelligence Technology. *International.*	Educational resources, Teaching robots, Artificial intelligence technology, Design and development of educational technology.	13
Ahammad, K., Chakraborty, P., Akter, E., Fomey, U. H., & Rahman, S. (2021). A comparative study of different machine learning techniques to predict the result of an individual student using previous performances.	Machine learning techniques, Prediction of academic performance, Analysis of previous performance of individual students.	10
El Aouifi, H., El Hajji, M., Es-Saady, Y., & Douzi, H. (2021). Predicting learner's performance through video sequences viewing behavior analysis using educational data-mining.	Viewing behavior analysis, educational data mining, Predicting academic performance with educational technology.	9
Zuo, M., Hu, Y., Luo, H., Ouyang, H., & Zhang, Y. (2022). K-12 students' online learning motivation in China: An integrated model based on community of inquiry and technology acceptance theory.	Motivation of online learning of student's, theory of acceptance of technology.	8
Mogas, J., Palau, R., Lorenzo, N., & Gallon, R. (2020). Developments for smart classrooms: Schools perspective and needs.	Development of smart classrooms, perspectives and needs of schools.	7
Cheng, X., Sun, J., & Zarifis, A. (2020). Artificial intelligence and deep learning in educational technology research and practice.	Artificial intelligence and profound learning applications in educational technology research and practice	7
Breines, M. R., & Gallagher, M. (2020). A return to Teacherbot: rethinking the development of educational technology at the University of Edinburgh.	The development of educational technology, creation, use of technology to improve the learning experience of university students.	6
Wang, J., Yang, Y., Li, H., & van Aalst, J. (2021). Continuing to teach in a time of crisis: The Chinese rural educational system's response and student satisfaction and social and cognitive presence.	Response of the Chinese rural education system to the COVID-19 crisis, impact on students' satisfaction and social and cognitive presence	6
Wang, J., & Zhan, Q. (2021). Visualization analysis of artificial intelligence technology in higher education based on SSCI and SCI journals from 2009 to 2019.	Artificial intelligence technology visualization analysis in higher education, based on scientific journals.	6
Salas-Pilco, S. Z., & Yang, Y. (2022). Artificial intelligence applications in Latin American higher education: a systematic review.	Systematic review of artificial intelligence applications in higher education in Latin America.	5
Ma, J. (2021). Intelligent Decision System of Higher Educational Resource Data Under Artificial Intelligence Technology.	Intelligent decision-making system based on data from educational resources in higher education, using artificial intelligence technology.	4
Nguyen, H. D., Mai, L. T., & Anh Do, D. (2020). Innovations in creative education for tertiary sector in Australia: Present and future challenges.	Innovations in creative education in the third sector in Australia, and its present and future challenges.	4

Source: SCOPUS Database.

Note: This Table Presents most Cited Topics by Author in the Category Adaptive Educational Technologies.

Figure 3 It illustrates the scientific production linked to the category of Educational and Adaptive Technologies by country, highlighting China as one of the countries with the highest productivity in this field of research.

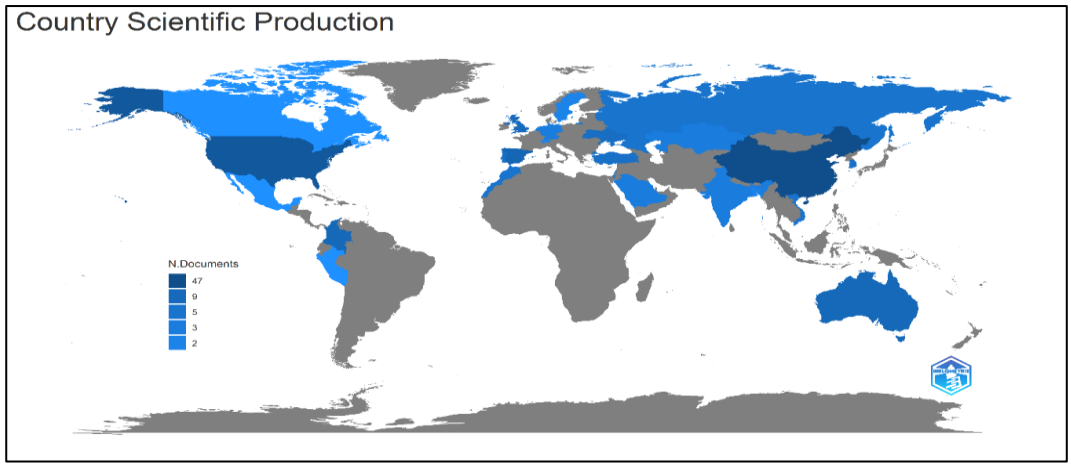

Fig 3. Worldwide Scientific Production in Studies Related to the Category of Educational and Adaptive Technologies.
Source: Bibliometric Analysis.

3.1.6 Findings Category Adaptive Educational Technology

The articles analyzed are generally about adaptive educational technology with the application of artificial intelligence in education. Specially, the impact of the COVID-19 pandemic on students' perception of online education and MOOCs in higher education institutions is discussed, as well as the response of the rural education system during the crisis. In addition, the role of technology in motivating students in online learning and the integration of technology in education is analyzed. The integration of topics such as robotics, the effectiveness of the educational environment based on artificial intelligence techniques, in the use of virtual classrooms in the development of training in the educational space are also addressed.

3.1.7 Informatics or Affective Computing

Table 7 shows the most cited authors in the computing or affective computing category during the last five years, together with their respective publications.

Table 7. Most Cited Topic by Authors in the Computing or Affective Computing Category Extracted from Wos.

Author and titles	Emerging and construct	Citations
Bond, M. (2020). Facilitating student engagement through the flipped learning approach in K-12: A systematic review.	Flipped Learning, Student Engagement, Learning, Systematic Research Methodology	108
Chen, X., Zou, D., Xie, H., & Wang, F. L. (2021). Past, present, and future of smart learning: a topic-based bibliometric analysis.	Smart learning, bibliometric analysis	38
Bălan, O., Moise, G., Petrescu, L., Moldoveanu, A., Leordeanu, M., & Moldoveanu, F. (2019). Emotion classification based on biophysical signals and machine learning techniques.	Classification of emotions, biophysical signals, machine learning techniques.	35

Dong, Y., & Zhu, S. (2023). Gender differences in creative design education: analysis of individual creativity and artefact perception in the first-year design studio.	Gender differences, individual creativity, artefact perception, design education.	0
Garcia-Castelan R. G. (2022). Predictive Models for Early Detection Of Engineering Students At Risk Of A Course Failure.	Development of predictive models to early detect engineering students, predictor variables and machine learning algorithms to generate predictions.	0
Cebral-Loureda, M., & Torres-Huitzil, C. (2021, December). Neural Deep Learning Models for Learning Analytics in a Digital Humanities Laboratory.	Neural deep learning models, learning analytics, digital humanities lab.	0
Neziri, I., Ahmeti, K., & Memeti, A. (2021). The Relationship Between Student Attitudes Toward Online Learning and Environmental Factors During Covid-19 Pandemic: The Case of the University of Tetova.	Student attitudes towards online learning, environmental factors, COVID-19 pandemic.	0

Source: WoS Database.

Note: This Table Present the Most Cited Topic by Authors in the Computing or Affective Computing Category.

Table 8, below, it shows and exhibits the most cited authors in the computing or affective computing category during the last five years, along with their respective publications.

Table 8. Most Cited Topic by Authors in The Computing or Affective Computing Category Extracted from Scopus.

Paper	Emerging categories	Citations
Bond M, 2020, Comput Educ	inverted learning, student engagement, K-12 education, systematic review.	108
Chen, X., Zou, D., Xie, H., & Wang, F. L. (2021). Past, present, and future of smart learning: a topic-based bibliometric analysis. International.	Smart learning, bibliometric analysis, educational technology, future of learning	38
Bălan, O., Moise, G., Petrescu, L., Moldoveanu, A., Leordeanu, M., & Moldoveanu, F. (2019). Emotion classification based on biophysical signals and machine learning techniques.	Classification of emotions, biophysical signals, machine learning techniques.	35
Chevalère, J., Lazarides, R., Yun, H. S., Henke, A., Lazarides, C., Pinkwart, N., & Hafner, V. V. (2023). Do instructional strategies considering activity emotions reduce students' boredom in a computerized open-ended learning environment?	Instructional strategies, Activity emotions, Boredom, Computerized and open learning environment	16

Source: SCOPUS Database

Note: This table presents the most cited authors in the affective computing category

Table 9 shows the authors who have investigated the topic of affective informatics during the last five years, along with their respective publications.

Table 9 The Authors Who Have Investigated in The Computing or Affective Computing Category During the Last Five Years.

Paper	Emerging constructs	*Citations*
San Segundo, R., & López Ongil, C. (2022). EMPATIA-CM: Comprehensive Protection of Gender-based Violence Victims through Multimodal Affective Computing.	Empatia-CM: it is a model that is based on multimodal affective computing.	*2*
Chanchí G, G.E., Sierra M, L.M. and Ospina A, M.A. (2020). Application of affective computing in the analysis of promotional videos for tourism in the city of Popayán-Colombia.	Affective computing, acoustic analysis, emotions; tourism	*2*
Quezada-Sarmiento, P.A. and Mengual-Andrés, S. (2019). Approaches to Cloud Computing and Affective Computing in the development of programming skills.	Cloud Computing, Approach to Developing Programming Skills, Affective computing to the development of programming skills.	*4*
Quezada-Sarmiento, P.A. and Mengual-Andrés, S. (2019). Principles of the semantic web and affective computing in a sustainable ecotourism through the development of an educational web application.	Semantic Web, web application, Affective Computing.	*6*

Source: SCOPUS Database.
Note: This Table Presents the Authors Who Have Investigated in the Affective Informatics Category

Figure 4 illustrates the scientific production linked to the category of Informatics or affective computing by country.

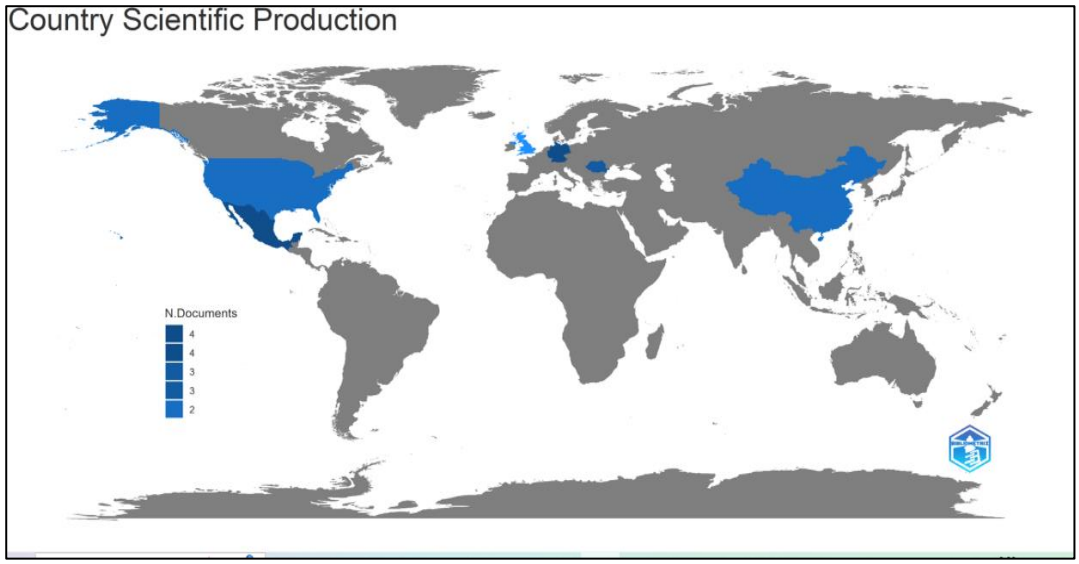

Fig.4. Worldwide Scientific Production in Studies Related to the Category of Educational and Adaptive Technologies.
Source: Bibliometric Analysis.

3.1.8 Findings in Informatics or Affective Computing

The studies reviewed in the category of informatics or affective computing show that this area is used to improve student participation and engagement, through the understanding of human emotions using biometric signals and machine learning techniques. An adaptive affective cognition analysis model using a deep convolutional neural network to understand student emotions in a university context is also presented, the use of deep learning models for learning analysis in a digital humanities laboratory is discussed.

3.1.9 Comprehensive Training

Table 10 shows the authors with the largest number of annual publications in the Comprehensive Training category. It is important to note that some authors appear with zero, which implies that their works are recently published. However, these contributions are considered of great relevance and value for research on this topic.

Table 10. Authors With More Annual Publications in The Comprehensive Training Category Deduced from The Wos Database.

Title and author	Emerging constructs	Citations
Mathematical concepts and their definitions for the training of computer engineers for society. (Bueno Hernández, Naveira Carreño y González Hernández, 2020).	Mathematical concepts, computer engineering education, student training, definitions of concepts, mathematical skills..	1
The relationship of students'emotional intelligence and the level of their readiness for online education: a contextual study on the example of university training in saudi arabia .(Alenezi, 2020).	Emotional intelligence, Online education, Preparation of students about the context of university education.	11
Training of tutors at the higher level with the model for the development and evaluation of academic competences. (Macias-Esparza, Canedo-Ortiz, Eudave-Munoz y Paez, 2018).	Tutor training, Academic skills, Training models, Skills assessment, higher education	1
Socio-Ernotionai Skills in Educationai Communities: Contributions to In tegrai Teacher Training (Aristulle y Paoloni-Stente,2019).	Socio-emotional skills, educational communities, Teacher training, Emotional competencies.	5

Source: WoS Database.

Note: This Table Presents the Authors, Emerging Constructs and their Respective Citations in the SCOPUS Database for the Comprehensive Training Category.

Table 11 presents the most cited authors on the subject of Comprehensive Education during the last five years, together with their respective publications.

Table 11. Most Cited Authors in the Comprehensive Training Category Extracted from the SCOPUS Database.

Paper	Constructos emergentes	Citations
Alenez, A. M. (2020). The relationship of students' emotional intelligence and the level of their readiness for online education: a contextual study on the example of university training.	Emotional intelligence online education Preparation for online education	11
Carrascosa, V. L., & Díaz, M. J. F. (2019). Diseño y validación de una escala para evaluar el funcionamiento de las tutorías en Educación Secundaria.	Tutorials, secondary education, operation of tutorials Design and validation of scales	9
Carrasco-Aguilar, C., & Varela, M. F. (2019). Formación Inicial Docente Y High Stakes Accountability: El Caso de Chile.	Initial teacher training, Accountability of high risk and professors	6
Kozlo, A. V., & Shemshurina, S. A. (2018). Fostering Creativity in Engineering Universities: Research Activity and Curriculum Policy.	Creativity, engineering universities, research and curricular policies.	6
Sirotiak, T., & Sharma, A. (2019). Problem-based learning for adaptability and management skills.	Problem-based learning, Adaptability skills, Management skills.	4

Source: SCOPUS Database.

Note: This Table Presents the Authors, Emerging Constructs and their Respective Citations in the Wos Database for the Affective Informatics Category.

Figure 4 illustrates the scientific production linked to the Comprehensive Training category by country, highlighting Russia as one of the countries with the highest productivity in this field of research.

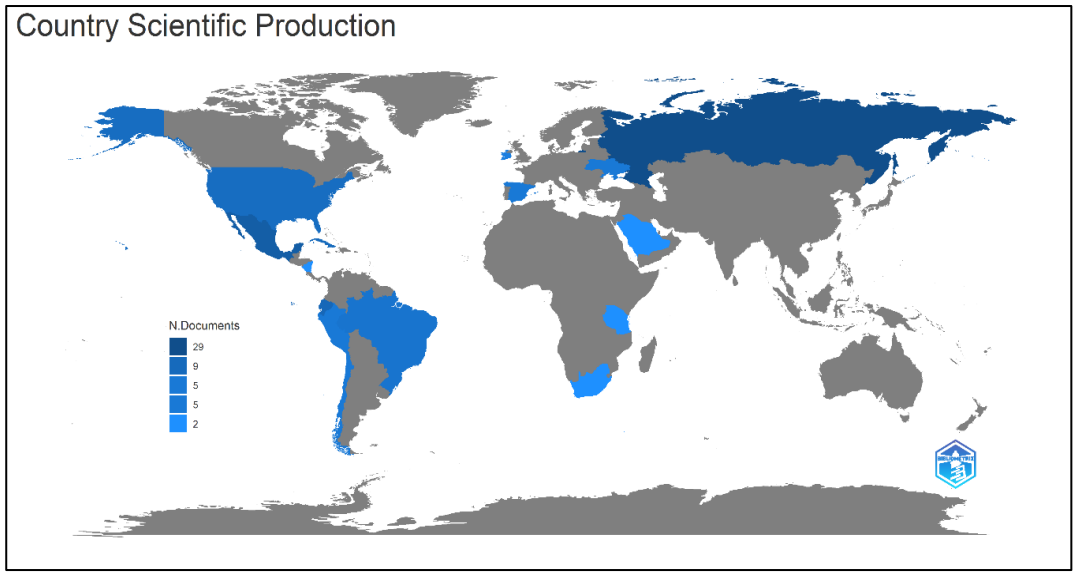

Fig. 4. Worldwide Scientific Production in Studies Related to the Category of Computing Or Affective Computing.
Source: Bibliometric Analysis.

3.1.10 Findings of the Comprehensive Training Category

The comprehensive training category includes a variety of studies that address education at different levels and approaches. The results showed focus on the need to integrate the teaching of mathematics with training in computer science to prepare computer engineers to face the challenges of today's society.

On the other hand, some studies highlight the importance of emotional preparation of students for success in online education and achieve their comprehensive training. Others focus on teacher training in higher education with a model for the development and assessment of academic competencies. They highlight the importance of socio-emotional skills in teacher training. The results indicate that educational communities that promote social and emotional skills help improve the quality of education and comprehensive teacher training.

4. Discussion of The Results

The discussion of the results of the systematic review and the meta-analysis of the previous scientific literature on the emerging didactic categories, pedagogical practice, adaptive educational technology, informatics or affective computing and integral formation, in correspondence with the outlined objectives, the general research question , the explanation of the results, limitations, implications and contributions of the study, show the relevance of addressing various aspects for higher education, from the didactic training of teachers to the inclusion of sustainability, inclusion and entrepreneurship skills in the curriculum. Likewise, the need to use adaptive educational technologies and emerging didactics to motivate students to learn and teachers to improve their pedagogical practice is emphasized. After that, the findings found for each category are discussed, where the agreements and disagreements regarding the topic under study are highlighted.

4.1. Emerging Didactics in Higher Education

Regarding the meta-analysis of the emerging didactic category, the authors discuss the importance of didactic training for higher education teachers and how this can improve the quality of teaching. Emerging didactic trends in higher education and the training needs perceived by teachers to adapt to them are addressed, such as artificial intelligence, microlearning, Virtual Learning Objects (OVA), gamification, video games and learning. mobile because they are tools that improve the quality of teaching that motivate students to learn. Topics addressed by these authors include digital literacy, digital didactics, inclusive teaching, change management, teaching social sciences, and contemporary history, among others. (Pando, 2028; Gómez Carrasco, López Facal, Rodríguez Medina, 2019; Scherman, Islam, Dikaya, Dumulescu, Pop-Păcurar, Necula, 2023; Ortega-Sánchez, Gómez-Trigueros, 2019; Erhorn, Möller, Langer, 2020; Moreno-Pino, Jiménez-Fontana, Cardeñoso Domingo, Azcárate Goded, 2021; Haas, Munzer, Santen, Hopson, Huang, Hudson, 2020; Palazón-Herrera, Soria-Vílchez, 2021; Li, 2021; Llonch-Molina and Parisi-Moreno, 2018; Keiding and Qvortrup, 2028).

4.2 Pedagogical Practice in Higher Education

The systematic review and meta-analysis of the pedagogical practice variable in higher education have highlighted the importance of technology in the teaching and learning process, especially during the COVID-19 pandemic. In addition, there has been an increase in the use and integration of robotics in the international educational space, the effectiveness of the educational environment based on artificial intelligence techniques, the use of flipped virtual classrooms and the personalization of learning through AI, have argued that pedagogical practice must evolve to adapt to education 4.0 in higher education.

It also highlights the importance of improving the pedagogical skills of teachers in higher education, the relationship of teachers with educational technology, the different feedback practices in higher education and their impact on teaching, the pedagogical design for learning. collaborative object-oriented, the implementation of blended education in the context of urban education and the pedagogical practices of mobile education at the primary and higher education levels. (Melnychuk et al., 2019; Gilbert et al., 2021: Shah et al., 2020; Chan & Luo, 2022; Damsa & Muukkonen, 2020; Perera et al., 2020; Bai, 2019 ; McGreal, Montoya and Agbu, 2022).

4.3 Adaptive Educational Technologies in Higher Education

The systematic review and meta-analysis of the variable adaptive educational technology in higher education has yielded promising results on the potential of artificial intelligence (AI) in education to personalize and adapt learning to the individual needs of students. Reviewed authors, including Luckin and Cukurova (2019), Seufert, Guggemos, and Sailer (2021), Renz and Hilbig (2020), Prendes Espinosa and Cartagena (2021), Ouherrou, Elhammoumi, Benmarrakchi, and El Kafi (2019), and Huang (2021), all are in favor of the implementation of AI in education and highlight different important aspects for its success, such as the understanding of learning, the development of technological skills and competencies for teachers, the continuous training of teachers and the identification and adaptation of learning to the emotions and individual needs of students. Although the authors are in favor of AI in education, they also identify barriers, such as a lack of AI knowledge and expertise and data privacy concerns.

4.4 Informatics or Affective Computing in Higher Education

The systematic review and meta-analysis of the computing variable or affective computing in higher education has yielded results that indicate the relevance, pertinence, and benefits of the application of affective computing to improve the quality of education. The reviewed authors are in favor of the application of affective computing in education and other fields. Bond (2020) found that the flipped learning approach can improve student academic performance when affective computing is incorporated, while Feng (2022) developed an adaptive affective cognition analysis model that can be used to analyze emotional state. of college students. Chanchí, Sierra and Ospina (2020) apply affective computing in the analysis of tourism promotional videos susceptible to being applied in education and Quezada-Sarmiento and Mengual-Andrés (2019) explore its use in the creation of an educational web application for ecotourism. sustainable.

4.5 Comprehensive Training

Systematic review and meta-analysis on comprehensive training is a broad and complex topic that involves multiple aspects of education. In light of the articles analyzed, positions can be presented for and against comprehensive training.

For its part, the article by Bueno Hernández, Naveira Carreño and González Hernández (2020) suggests that comprehensive training should include training in technical and specialized skills. Similarly, the article by Macias-Esparza et al. (2018), supports the formation of academic competencies, in this case for higher education teachers, which suggests that comprehensive training should include training in pedagogical skills. On the other hand, the article by Alenezi (2020) focuses on the relationship between emotional intelligence and preparation for online education, suggesting that comprehensive training should include training in socio-emotional skills.

5. Conclusions

Taking into account the objective of analyzing the implications of pedagogical practice mediated by emerging didactics, adaptive educational technologies and affective computing in the training of students in the context of higher education; The systematic review of the studies on the emerging didactic categories, adaptive educational technologies, informatics or affective computing, pedagogical practice and the integral formation of the students, allowed to identify and discuss 87 articles in the context at the micro, meso, macro and mega levels. Discussion of the implications and contributions of the study revealed the following conclusions and recommendations for future research and practice:

- Emerging didactics and adaptive educational technologies have proven effective in improving student learning. In particular, adaptive technologies have been shown to have a positive impact on academic performance.
- Affective computing, which refers to the use of technologies to detect and respond to students' emotions, is also useful for improving students' learning and emotional well-being. For example, some intelligent tutoring systems use affective computing techniques to provide personalized feedback that takes into account the student's emotions.
- The combination of educational technologies with solid pedagogical approaches and the active participation of the teacher is essential to achieve the integral formation of the students.

- Educational technologies should not be used as a substitute for direct teacher instruction, but rather as a complementary tool that can improve the quality and effectiveness of teaching.
- Due to the diversity of educational technologies and pedagogical approaches available, more research is needed to determine which combinations work best in different educational contexts and for different groups of students.

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