A Systematic Review and Trend Analysis of Personal Learning Environments Research

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***Abstract*—The concept of personal learning environments (PLEs) is relatively new and is continuously developing. Over the past decade, there has been a significant upsurge in the number of PLEs-related research. Nevertheless, there is a lack of recent systematic reviews and trend analysis covering many PLEs studies; to the best of our knowledge. Therefore, the current systematic review is significant and indispensable in reviewing journal articles that discussed PLEs between 2000 and 2020. We searched Web of Science, Scopus, Sciences Direct, JSTOR, Springer, Google Scholar, and IEEE Xplore for studies published in English without limit in location or time to retrieve accurate results. Trend graphics for the extracted themes were also analyzed using descriptive statistics in Excel. According to the defined inclusion criteria, one hundred forty-eight articles were selected for the analysis. This study reveals that literature on PLEs has progressed from 2000 to 2020; the majority of PLEs-related articles were published between 2011 and 2020, with the year 2013 having the highest number of published articles (17 articles), followed by 16 papers published in both years 2014 and 2017. We found that the published PLEs research originated from 46 countries; 26 (17.6%) were from Spain. The majority of the authors had education, computer science, information technology and engineering backgrounds. This review also showed that numerous platforms had been used in PLEs research, with Web 2.0 the most commonly used platform. We noted that the most common objectives of the included articles were PLEs custom system development, analysis of the PLEs, description of experiments, investigations, development of factor models, framework development, and examination. The most common theoretical perspectives in the published articles were self-regulated learning, self-directed learning, and constructivism. The current systematic review and trend analysis can become a guidance platform for researchers, educators, policymakers or even journal publishers for future research in PLEs research.**

***Index Terms*—Personal learning, personal learning environment, systematic review, trend analysis.**

I. Introduction

Personal learning (PL) is identified as lifelong learning, which deals with getting information differently [1]. According to Schwartz (2016), learners should be provided with the flexibility to enhance their various skills to analyze data critically [2]. In this manner, the notion of Personal Learning Environments (PLEs) was initially studied by Olivier and Liber [3]. They addressed the PLEs as a crucial resource for e-learning and Interactive Learning Environments (ILE).

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In the same vein, Kulathuramaiyer and Maurer (2007) portrayed PLEs as a great assistance to information management and the cognitive load that accompanies it [4]. PLEs have been cited as a reliable user interface to meet the needs of lifelong learners to manage their educational careers [3]. According to Taraghi and Ebner (2011) and Alalwan *et al*. (2019), in an environment where learners can integrate the distributed resources, applications and tools in a single platform can be tailored to individual learners to offer an acceptable circumstance for developing their specific needs in a study environment that allows people to interact within collaborative and distributed environments [5], [6]. In this situation, PLEs are an instructive approach that enables students to employ social media to enhance self-regulated learning in both official and non-official pedagogical contexts [7], [8].

Many researchers conducted different studies and found that the PLE notion has implications on open-access online learning and learner-based guidance, self-direction, and self-regulation [9], [10]. Counted as the significant point of PLEs research, Buchem *et al*. (2012) believe that creating customized platforms would not be the purpose of the study by focusing on obtaining the learners' activity in terms of their employment of technology for supporting their learning process [11]. Also, Van Harmelen (2006) considers that PLEs play a significant role as a system that assists learners in managing and controlling learning by setting their targets and communicating with other learners to fulfil their objectives [12]. This explanation in the perspective of Panagiotidis (2014) is identified as a particular designed system that covers many external tools and resources for developing a customized learning experience that can be accessed individually [13], which is in line with the perspective of several researchers who believe that PLEs enables learners to engage their peers, resources as well as services in a broad context [14]. Apart from the significant role of the PLEs in learning and engaging learners, the PLEs have been challenging the traditional Learning Management System (LMS).

According to Ullrich *et al*. (2010), LMS should be recognized as a suitable solution for institutions [14]. In this sense, PLEs should ideally aim to enhance the learners' cognitive abilities, redefine the pedagogical process, and integrate third-generation LMS to design technology-enhanced practices and opportunities [15], [16]. Therefore, Hicks and Sinkinson (2014) and Patricia Ibañez *et al*. (2019) believe that it is crucial to enhance PLEs, mainly because digital information is being developed [17], [18]. Thus, learners will establish their own self-reflective and learning environments and create and manage their learning environments through the required tools [19], [20].

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According to Schwartz (2016) and Al-Rahmi *et al*. (2019), since the components such as learning progress, technology and resources are provided to help all learners, the outcome would be even more attractive to the students and prompt greater responsibility and improve the results [2], [21]. Therefore, over the course of the previous century, educational professionals and researchers have addressed several theories to identify how learners need, organize and employ skills and knowledge. Under this circumstance, various approaches have been organized for helping learners and educators as well as researchers.

There is a lack of recent systematic reviews and trend analysis covering many PLEs studies to the best of our knowledge. Therefore, the current systematic review is significant and indispensable in reviewing journal articles that discussed PLEs between 2000 and 2020. The present systematic review and trend analysis can become a guidance platform for researchers, educators, policymakers or even journal publishers for future research in PLEs research.

Consequently, the current systematic review is crucial to review journal articles that discussed PLEs to investigate the following research questions in particular:

1) What is the year of publication, the country of origin of published articles on the PLEs, the author background between 2000 and 2020?
2) What are the objectives and research methodology of these published articles?
3) What are the most common PLEs platforms that were mentioned in these published articles between 2000 and 2020?
4) What is the theoretical perspective on personal learning environments mentioned in these published articles between 2000 and 2020?

II. Methodology

It should be considered that systematic literature is a fundamental scientific activity that enables scientists to consider authors' perspectives in a specific area. A systematic literature review synthesizes, evaluates, and identifies research results for creating a summary of evidence that can effectively contribute to practice. In general, systematic review methodology makes use of principles that are needed in primary research. Typically, this review addresses above mentioned specific research questions with evidence from the studies.

A systematic literature review has been considered in this research because it offers several benefits. First of all, they serve to deliver a comprehensive and clear overview of the available evidence on a specific topic [22]. In addition, these reviews help identify research gaps in the current understanding of the topic and field. They are capable of highlighting methodological concerns in studies that can be further utilized for improving work. They can also be considered for identifying questions for which the evidence seems to provide clear answers. It is important to note that a systematic literature review was performed to identify journal articles that discussed PLEs between 2000 and 2020.

A. Data Sources and Search Strategy

We searched Web of Science, Scopus, Sciences Direct, JSTOR, Springer, Google Scholar, and IEEE Xplore for studies published in English without limit in location or time to retrieve accurate results. According to the research questions mentioned earlier, we used a combination of search terms, including 'Personal Learning Environments' OR 'Personal Learning Environment' OR 'Personalized Learning Environment'.

B. Eligibility Criteria

The inclusion criteria were 1) Studies published in most influential journals, 2) Studies must be peer-reviewed in a journal. The following are the exclusion criteria of this systematic review: 1) a language other than English, 2) citations without full text, 3) Published articles in symposium and conference proceedings OR workshop OR editorials OR commentaries OR are mentioned in a technical report OR MS/Ph.D. thesis.

C. Quality Assessment of the Included Articles

We evaluated the methodological quality of the included articles by the Newcastle-Ottawa Scale for grading the quality of observational studies [23]. The quality rating was out of 9, scores between 0 and 3 referring to a low rate, scores between 4 and 6 medium quality, scores between 7 and 10 high quality. The evaluations of all articles were compared between the evaluators, with discrepancies resolved unanimously.

D. Study Screening and Data Extraction

To guarantee sufficient data to monitor research trends, the publication period was set as a decade from 2000 to 2020. The type of publication was selected as "peer-reviewed articles".

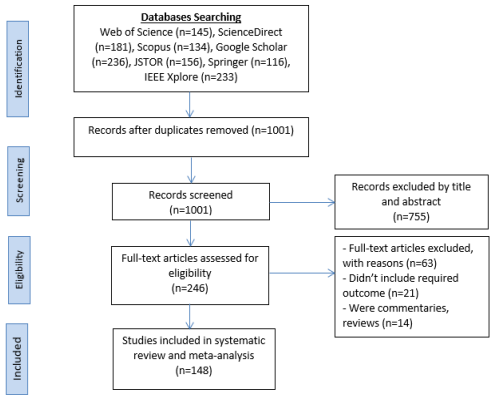

Fig. 1. The PRISMA flowchart presenting the search strategy for the current systemic review.

The resulted articles from the literature search (1201 articles) were imported to EndNote X8 software to eliminate duplicates and manage the screening processes. The remained articles after removing duplications were (1001 articles). Then, 755 articles were excluded by title and abstract screening. Eventually, the authors did the full-text screening and reviewing, working independently and duplicating to decide their eligibility for full-text reviewing. One hundred forty-eight articles were eligible to be included in the systematic review.

Fig. 1 illustrates the PRISMA flowchart to show the search

strategy for the systematic approach for collection, processing, and reviewing the articles [24].

The critical information extracted from the articles included 1) country of the first author, 2) year of publication, 3) category of study objective, 4) study design, 5) the used platforms, 6) theoretical perspectives, 7) the employed data collection instrument, 8) study population, 9) author background.

E. Data Analysis

Trend graphics for the extracted themes were analyzed using descriptive statistics in Excel.

III. Results and Discussion

We have collected more than 148 articles related to PLS. As PLS is becoming an issue among educators, we can see an increase in the number of articles available per year from 2000 until 2020.

The inclusion of many articles related to PLEs could be attributed to the multi-disciplinarity of the PLEs notion. It has been used in education, information technologies, computer science, engineering, economics, information management, business, biotechnology, health and life sciences, communication, informatics, telecommunication, medicine and health, artificial intelligence, etc.

In practice, the implementing of PLEs in various educational levels and fields is entirely under investigation [25]-[29]. PLEs is an expanding field, especially in academic research, as evidenced by the increasing number of research papers published in the last ten years and the launch of the PLE Conference, known as PLEConf (pleconf.org).

Advocates of PLEs propose that through effective building and use of PLE, learners will regain control of their learning process through the ability to select and mix from several alternatives (among other actions) to capture, store, classify, analyze, create, share, disseminate and process information, hence generating knowledge [26], [30]-[32].

A. The Publishing Year of PLEs-Related Articles

Our analysis showed that most PLEs-related articles were published between 2011 and 2020.The year 2013 had the highest number of the published articles (17 articles), followed by 2014 and 2017 as 16 papers were published in these two years (Fig. 2).

The first appearance of the PLEs acronym was in November 2004 as a title of a session in the 2004 JISC / CETIS conference [33]. In 2001, the NIMLE (Integrated Managed Learning Environment for Northern Ireland) was established; accordingly, Brown (2010) selected the start date for the PLEs approach. Taraghi, Ebner, and Schaffert (2009) [32] referred to Olivier and Lieber (2001) among the earliest to express the idea of PLEs [3].

We can consider PLE as a concept in fashion when numerous exceptional editions were launched from recognized publications in 2008: E-Learning Articles [34] or Interactive Learning Environments [35].

The notion of the personal learning environment has a long history. Based on Google Ngrams (http://ngrams.googlelabs.com/), the term personal learning environment was first quoted in 1965. We noticed that a 1969 publication of the University of Washington emphasized that each student's interests and aspirations seem to be a precondition for building their learning environment.

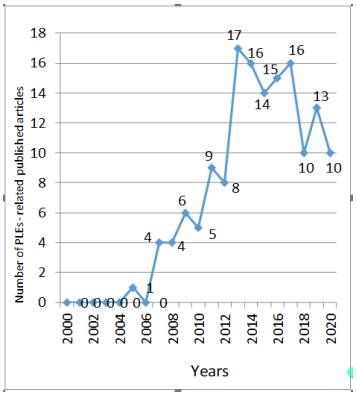

Fig. 2. Distribution of the published articles according to the publication year.

Until the previous year, in 1968, the Association for Student Education also referred to the term PLE, which could be drawn up by a qualified associate to share experiences in a learning environment.

Consequently, we can guess that the personal environment for learning originates from thoughts regarding the individualization and personalization of education in the late sixties. Nevertheless, the technological attitude is first seen in the twenty-first century. If we recognize that around that moment, the web and computer technologies have been presented for more than 10 and 20 years, respectively, why hasn't PLE appeared before?

B. First Author Country

We have extracted that researchers from forty-six countries published articles between 2000 and 2020. The most published articles, twenty-six, are from Spain. The second and third most published papers are from the USA, fifteen, and the UK, twelve (Fig. 3). We can also infer that literature on personal learning environments (PLEs) is spread across continents. Researchers are rigorously working on this emerging field to make the most out of it. The other countries are Germany, Finland, Thailand, Malaysia, India, Pakistan, Brazil, etc.

C. First Author Background

Most of the authors had education, computer science, information technology and engineering background. The rest came from various backgrounds such as communications, telematics, informatics and many more (Fig. 4).

IV. Research Objectives

A mind map was developed to visually organize information on the themes of personal learning environments, including articles, research design, and data collection (Fig. 5). We noted that the most common objectives of the included articles were PLEs custom system development, analysis of the PLEs, description of experiments, investigations, development of factor models, framework development, and examination.

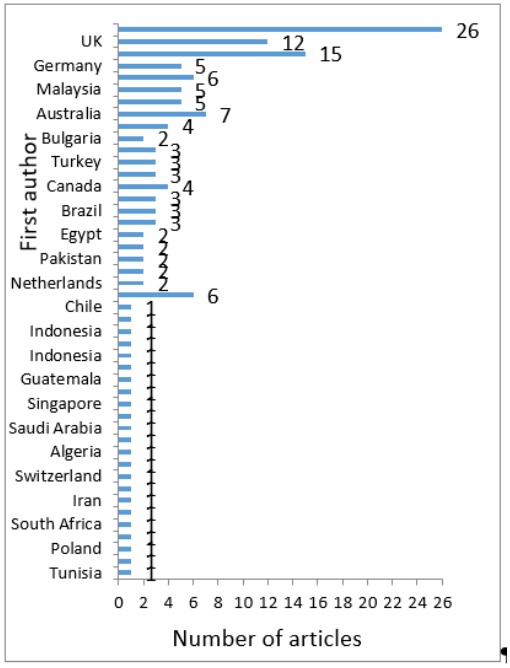

Fig. 3. Distribution of the published articles according to country of first authors.

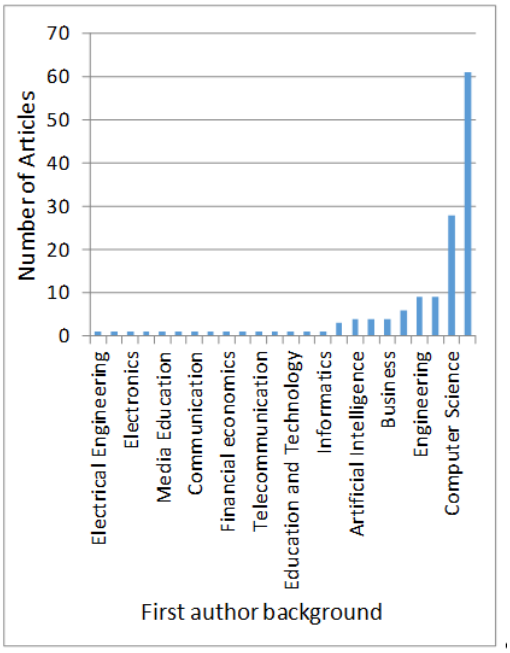

Fig. 4. Distribution of the published articles according to first author background.

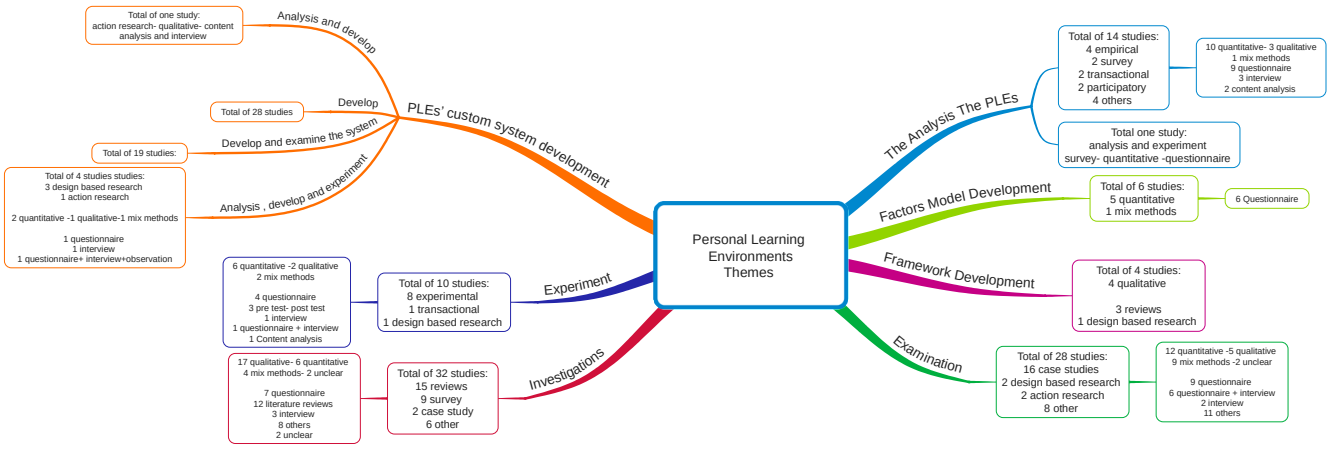

Fig. 5. A mind map to visually organize information about articles objectives, research design, and data collection instrument.

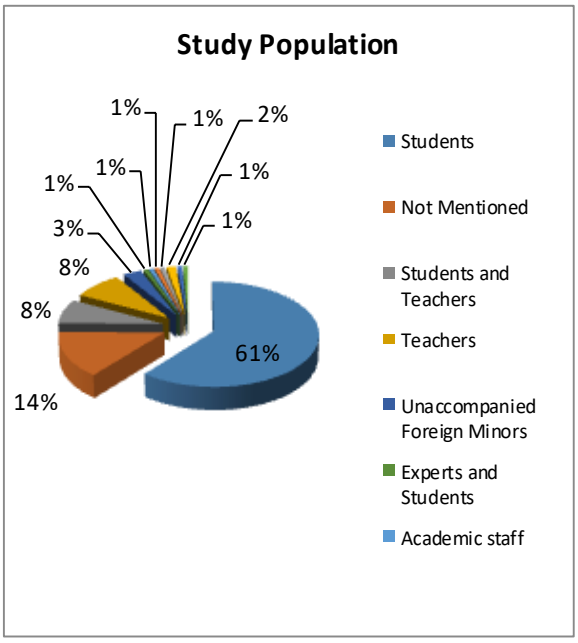

Fig. 6. Distribution of the published articles according to the studied population.

The four principal research methodologies used in published papers were system model development, case study, survey design, and review articles. These primary methodologies have helped develop and test the literature on PLEs.

Various data instruments were used for data collection in the included articles. The most employed tools were questionnaires, literature reviews, and interviews.

V. Study Population

Fig. 6 shows that 81 (61%) published articles on topics related to PLEs targeted academic staff, 11 (8%) targeted students, 11 (8%) targeted students and teachers together. Other population groups were also found.

VI. Platforms

This review showed that numerous platforms had been used in PLEs research. Web 2.0 was the most commonly used platform in PLEs research, as it has been used unilaterally in

27 articles and with other social media platforms in 6 articles. The mash-up tools were used in 26 articles. The custom e-learning systems were used in 24 articles. LMS has been unilaterally used in 7 papers and 6 articles with Web 2.0 or other social media platforms (Table I).

TABLE I: THE USED PLATFORMS IN THE INCLUDED ARTICLES

Platform	References	Platform	References
Web 2.0	[36]-[63]	Open-access services	[64]
Mash-up tools	[28], [54], [65]-[89]	Open-Source Software	[90]
Custom e-learning systems	[91]-[115]	Cloud-based tools	[116]
Web 2.0 and social media	[117]-[123]	Mobile learning	[124]
Social media	[7], [35], [89], [125]-[139]	SymbalooEDU	[140]
Facebook	[141]-[143]	Mooc	[144]
LMS	[145]-[148]	ICT	[149]
Moodle	[150], [151]	Google apps	[152]
Tag-based system	[153], [154]	WordPress	[155]
ePortfolio	[33], [156]	Multimedia	[157]
Blogs	[158]	Symbaloo	[159]
Open Textbooks	[160]	e system	[161]

After reviewing the literature, we can describe the three LMS generations using many features, comprising interoperability, interaction, practice, and learning knowledge.

The first generation of PLEs includes proprietary solutions and concentrates on content dissemination. This generation is linked to the theory of computer-aided education systems. These learning systems are self-reliant and permit very little or no interaction between pupils and tutors.

The second generation of LMS relies on so-called classroom-based learning systems, which deliver central learning from content dispersed by lecturers. Such approaches support interaction between teachers and students and employ several technologies to provide learning actions. For instance, marketable platforms like Blackboard (www.blackboard.com), open-source systems such as Moodle (www.moodle.org), Sakai (www.sakaiproject.org), and dotLRN (www.dotlrn.org). Since IT systems are dynamic, all structures of these platforms enable extensions [142], [162], like Blackboard Building Blocks, WebCT Powerlink's, Sakai's Tech Portability Profile tools, and Moodle Modules. Nonetheless, these platforms are independent and cannot be reused in various environments. Notwithstanding their apparent contributions, they present a heuristic experience of the learning context [163] while remaining centralized and locked. Users cannot customize their learning environments, and a marked shift occurs from the learning environment to a daily learning environment.

Third-generation learning management systems are service-oriented, allowing users to easily create individual and reusable learning contexts [164]. They also use open Internet standards to support lightweight interoperability. Such characteristics make the 3rd generation of learning platforms user-centered. At this point, half of the third-generation LMS implementation is targeted PLEs. In these environments, the learning experience is enhanced by creating and using individual contexts. This allows for substantial methodological flexibility and could create a new model of virtual courses. These courses can be considered as a combination of LMS educational services and a range of external services. Most of the existing e-learning platforms belong to the 3rd generation, and some have gotten institutional acceptance [165].

Belonging to the 3rd generations of e-learning systems, PLEs have been proposed as a resolution to address the risks of VLEs by giving learners additional control and freedom in selecting and disseminating various tools and strategies to guide their learning and pursue their varied educational aims [28] (A designed framework for Personal Learning Environment). According to many researchers, PLEs help learners blend their personal and professional interests into one place and learn from each other's skills, experiences and knowledge [166], [167].

Besides, many researchers believe that the concept of PLEs has implications for open online learning, learner-based guidance, self-guidance issues and self-regulation [10], [52]. In this sense, Haworth (2016) believes that PLEs are Web 2.0 and social media tools that empower learners to achieve their learning [148].

VII. LIMITATIONS

Meanwhile, to the best of our knowledge, this review has also encountered some shortcomings and challenges which need further study in the future. The overwhelming number of published papers may los relevant articles; several literature review studies face this issue. Moreover, the effort to build research by identifying keywords is critical to the search process.

The keyword identification technique was implemented using the snowball process to determine the implications or keywords relevant to the study. Articles can also be overlooked by removing relevant information or keyword sets because of the limited time frame.

Nevertheless, the study also faces potential constraints arising from selection criteria. For instance, this study focused only on journal articles and was limited to documents written only in English. Thus, other relevant articles not written in English and were not published in journals may not be included.

VIII. THEORETICAL PERSPECTIVES

Our review showed that the most common theoretical perspectives in the published articles were self-regulated learning (43 articles), self-directed learning (18 articles), and constructivism (15 articles) (Table II).

The notion of PLEs is relatively novel and still under development. We identify various theoretical aspects of PLEs to participate in the additional growth of their applications. PLEs have strong similarities to personal learning goals. PLEs intend to offer students the opportunity to shape learning environments according to their requirements. The active role of students and self-guidance in their learning was emphasized [15], [31].

TABLE II: THE USED THEORETICAL PERSPECTIVE IN THE INCLUDED ARTICLES

Theoretical Perspectives	References	Theoretical Perspectives	References
Self-regulated learning	[7], [38[, [41], [43], [48], [54], [56], [57], [63], [64], [67], [68], [78], [86], [88], [91], [102], [104], [111], [113], [115], [119], [121], [122], [132]-[134], [136], [137], [139]-[141], [143], [145], [147], [168]-[173]	Self-efficacy	[105]
Self-directed learning	[35], [42], [47], [55], [62], [65], [66], [75], [85], [98], [120], [142], [150], [154]-[157[, [174]	Transformational leadership and constructivism	[175]
Constructivism	[33], [39], [45], [49], [79], [84], [91], [93], [99], [101], [123], [127], [131], [138[, [159]	Connectivism & self-regulated learning	[75]
Self-learning	[87], [103], [128], [176]	Socio-cultural theory	[50]
Lifelong learning	[125], [151], 161]	TAM	[61]
Connectivism	[51], [144], [158]	Constructivism & Connectivism	[76]
Self-Reported Learning	[149], [177]	Self-directed + Connectivism	[53]
Lifelong theory	[59]	Technology-enhanced learning	[178]
Personal construct theory	[179]	Technology acceptance models	[152]
Self-disclosure learning	[129]	Situated Learning	[82]
Collaborative learning	[106]	Constructivism+ Searle's theory	[112]
Mobile learning theories	[72]	Epistemological	[180]

This is strongly associated with personalized learning goals by leveraging students' diverse capabilities, strengths, and interests to enhance participation and realize potential [181]. Personalization emphasizes learning as students are encouraged to present their exclusive concepts and backgrounds to the learning condition as resources that the entire class can use [182]. Leadbeater (2004) realizes personalization on a more comprehensive general level and describes a situation in which various public services, such as schools, are environments in which students make decisions regarding their learning in a particular, self-administered manner. Similar goals are associated with the idea of PLEs [183].

Furthermore, the use of PLEs has the probability of promoting so-called 'ownership'. Attwell (2007) argues that PLEs are student-controlled learning spaces [31].

Mott (2010) also stresses students' self-regulating role by describing PLEs as matrices of resources created, chosen and organized by students [184].

Such definitions stress student responsibility, control and modification of learning spaces and learning methods. The descriptions correspond with the Jonassen and Rohrer-Murphy (1999) visions of ownership, giving students the ability to define and control their learning goals and methods. It is said that ownership in these conditions provides students with more useful learning experiences [185].

Tolmie and Boyle (2000) denote ownership influencing on student activity in participating in learning situations [186].

Similarly, Issroff (2005) and Pintrich and Boyle (1993) claim that confidence in control significantly stimulates students and positively affects their academic performance [187], [188]. It is assumed that student-run PLE with self-structured self-learning increases ownership and emotion control and leads to more helpful learning experiences.

Boekaerts (1999) stated that self-regulated learning is a constructive and self-directed process that focuses on the skills of students beyond knowledge, i.e. learning, planning, implementation, monitoring and evaluation [189]. Hakkarainen *et al*. (2005) propose that cognitive procedures can be categorized into three levels: Level I includes identification and classification of phenomena and performance of learning practices [190]; Level II involves functions of inquiring and giving explanations, etc.; Level III is the level beyond cognitive emphasized in self-organized learning.

Hakkarainen *et al*. (2004) stated that the role of students in learning usually remains in lower-level activities, and the role of the teacher includes upper and higher-level processes [190]. The specific goal of using PLEs is to promote beyond knowledge in student activities. Students are responsible for selecting suitable tools and designing content for their environments to promote their learning better.

Such ideas are interesting and raise inquiries about the roles and responsibilities of both students and teachers. The issue of students as self-organized learners employing online resources has been introduced earlier, particularly in the late 1990s before Web 2.0. Lehtinen (1997) defined PLEs as "romantic constructivism", the statement that students are skillful in employing open learning environments, discovering the suitable sources and information, and the most effective learning methods, etc. [191].

IX. CONCLUSION

There is a lack of recent systematic reviews and trend analysis covering a large number of PLEs studies. Therefore, the present systematic review and trend analysis can become a guidance platform for researchers, educators, policymakers or even journal publishers for future research in PLEs research. The current systematic review is significant and

indispensable in reviewing journal articles that discussed PLEs between 2000 and 2020. The key information extracted from articles included 1) country of the first author, 2) year of publication, 3) category of study objective, 4) study design, 5) the used platforms, 6) theoretical perspectives, 7) the employed data collection instrument, 8) study population, 9) author background. This study reveals that literature on PLEs has progressed from 2000 to 2020; the majorities of PLEs-related articles were published between 2011 and 2020, with the year 2013 having the highest number of the published articles (17 articles), followed by the years 2014 and 2017 as 16 papers were published in each of these two years. We also found that the published PLEs research originated from 46 countries; 26 (17.6%) were from Spain. The majority of the authors had education, computer science, information technology and engineering backgrounds. This review also showed that numerous platforms had been used in PLEs research, and Web 2.0 was the most commonly used platform in PLEs research. We noted that the most common objectives of the included articles were PLEs custom system development, analysis of the PLEs, description of experiment, investigations, development of factor models, framework development, and examination. The most common theoretical perspectives in the published articles were self-regulated learning, self-directed learning, and constructivism. Conclusion: The current systematic review and trend analysis can become a guidance platform for researchers, educators, policymakers or even journal publishers for future research in the realm of PLEs research.

Conflict of Interest

The author(s) declared no potential conflicts of interest concerning the research, authorship, and/or publication of this article.

Author Contributions

SA and NY conducted the research, analyzed the data, and wrote the paper; all authors had approved the final version.

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