

From Self-Directed Digital Learning to Human Resource Development: Tracing the Knowledge Attainment Journey through a Bibliometric Lens

Reshma Mohammed*, Dharchana Sivasamy Velumani, Brindha Ganesan

Department of Management, PSGR Krishnammal College for Women, Coimbatore, Tamil Nadu, INDIA.

ABSTRACT

Self-directed learning has gained considerable importance in digital learning environments especially in the post pandemic era. As learning becomes more spontaneous, learner centered and technology mediated, this ability to independently plan, manage and evaluate their own learning process has become critical for academic success, professional development and organizational competitiveness. Despite this, research on SDL in digital learning contexts remains fragmented and under researched. Also, its implications for employee development and organizational learning require scholarly attention. The present study has adopted a bibliometric approach to map the thematic evolution, intellectual structure and research landscape of SDL in digital learning environments. 2268 articles retrieved from the Scopus database through the PRISMA framework, were analyzed through Biblioshiny (Bibliometrix R) and VOSviewer software. Productivity analysis, co-authorship analysis, co-citation analysis, thematic evolution, keyword co-occurrence analysis, and thematic mapping were conducted to identify major research trends, influential contributors, and emerging themes. Additionally, a subset of 109 studies was examined to explore the integration of SDL with employee development, workplace learning, and human resource development. The findings reveal an exponential increase in SDL-related research particularly after the COVID-19 pandemic. Thematic analysis indicates the emergence of dominant subthemes like self-regulated learning, learner autonomy, motivation, metacognition, online learning, mobile learning, and e-learning. Co-citation analysis demonstrates that the field is theoretically grounded in social-cognitive, motivational, and technology-enhanced learning perspectives. Further analysis also revealed that more studies integrate SDL with workplace learning, continuous professional development and lifelong learning. The study finds that SDL is being positioned more as a strategic capability that can encourage continuous learning, workforce agility, and professional competence in technology-driven workspaces. These are quite relevant to the lifelong learning demands associated with emerging Industry 5.0 contexts.

Keywords: Bibliometric Analysis, Industry 5.0, SCOPUS, Self-directed Learning, VOSviewer.

Correspondence:

Reshma Mohammed

Department of Management, PSGR
Krishnammal College for Women,
Peelamedu-641004, Coimbatore,
Tamil Nadu, INDIA.
Email: reshmam@grgsms.ac.in

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INTRODUCTION

In today's post-pandemic world, where everything is happening online, learning and knowledge transfer are also expected to happen instantaneously and at a greater speed. The rapid digitalization of learning ecosystems and the emergence of Industry 5.0 have changed how knowledge is created and transferred across educational and organizational settings. Today's workplaces demand continuous up skilling and reskilling to meet the evolving industry demands (Celino *et al.*, 2025). The increased adoption of digital learning resources and the

integration of Artificial Intelligence (AI) have intensified the transition towards digital learning ecosystem from traditional ones (Min Young Doo, 2023). Apart from facilitating professional development, lifelong and continuous learning, these digital learning resources ensure sustainability, accessibility, inclusivity, high level of personalization and are self-paced to suit every learner's unique needs (Halkiopoulou and Gkintoni, 2024).

Having said this, it has to be noted that availability of resources alone will not ensure that learning and subsequent knowledge transfer will happen. Several theories like Social Cognitive theory of Bandura and Self-Determination theory given by Deci and Ryan emphasize that factors like individual motivation, goal orientation, self-efficacy, and learning intention play an important role in determining that the learning outcome is attained (Kelly, 2020). These theories give due importance to the learner characteristics and it is in this context, that Self-Directed Learning (SDL) emerges as a meaningful and significant construct. It can



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be defined as the ability of individuals to take full autonomy of their learning - which includes setting learning goals; selecting appropriate learning resources; evaluating one's learning process and ensuring fulfillment of the same (Collier, 2022). This ability is particularly crucial in digital learning environments where there is minimal instructor supervision (Wardat *et al.*, 2023). Furthermore, in knowledge intensive sectors like Healthcare, Management, and Information Technology the individuals are expected to stay updated, and adopt continuous learning practices (Jin and Kim, 2024). Similarly, students pursuing higher education are also required to possess self-learning capabilities to improve their employability skills in today's competitive job market. Learners with high Self-Directed Learning (SDL) hence, have more chances of thriving in digital learning ecosystems. SDL can help individuals to mitigate through the many challenges of digital learning environment like learner distraction, disengagement, and difficulty in sustaining motivation to learn (Isabel *et al.*, 2005). In light of all these discussions, it is clear that learning in technology mediated environments is learner dependent and SDL can help learners navigate through the challenges posed by such ecosystems.

Earlier studies have acknowledged the importance of self-directed learning for successful learning outcomes (Si, 2022). But studies that explore SDL in digital learning contexts are scarce (Wang *et al.*, 2024). The few bibliometric studies (Suhaimie *et al.*, 2025) that explore the themes associated with online and digital education have examined self-directed learning only as a subsidiary component within broader digital learning discussions. Furthermore, research about SDL is highly fragmented, across educational, healthcare, and professional learning contexts (Wang *et al.*, 2024). Also, the integration of self-directed learning with organizational and HR contexts is largely missing (Taherdoost and Madanchian, 2023). This is the research gap the present study aims to close.

The present study thus, has conducted a Bibliometric Analysis to explore the intellectual structure, thematic evolution and future trends of self-directed learning in digital learning environments. Additionally, the study also examines the intersection between the construct, digital learning environment and its workplace implications. This will throw light on the implications of SDL for human resource development in contemporary workplace settings. By doing this, the study will not only contribute to SDL literature but also help to discover its potential as a strategic capability very relevant to organizational adaptability, lifelong learning and Industry 5.0 driven workforce transformation.

STUDY OBJECTIVES

Primary Objectives

- To examine the thematic evolution and research landscape of Self-directed learning in the context of digital learning environments in post pandemic context.
- To identify the emerging keywords, conceptual themes and research trends shaping self-directed learning research in digital learning contexts.
- To identify the prominent authors, organizations, sources, and countries who have made significant contributions to research about self-directed learning in digital learning contexts.

Secondary Objective

To examine the thematic linkage between research on Self-Directed Learning (SDL), digital learning, employee and human resource development in contemporary organizational contexts.

RESEARCH QUESTIONS

- RQ1a. How has research about SDL within digital learning contexts evolved over time?
- RQ1b. What has been the impact of Covid19 on the SDL research in digital learning contexts?
- RQ2. What are the dominant and emerging keywords and themes in the context?
- RQ3. Which authors, organizations, journals, and Countries have significantly contributed to research related to SDL in digital learning contexts
- RQ4. How research about SDL within digital learning context has been integrated with themes like employee development, organizational learning, and human resource development in digital learning environments?

METHODOLOGY

The study used the principles of scientometric to evaluate the research available on self-directed learning in the context of digital learning and its importance for employee development. Existing research on the concept has been evaluated based on performance measurement and scientific mapping (Donthu *et al.*, 2021; Basumatary *et al.*, 2023). The present study adopts a bibliometric and exploratory approach to examine the research landscape of SDL in digital learning contexts. Performance analysis was done to understand the productivity of researchers, countries, and organizations towards the topic. Science mapping focused on network visualization of authorship, keywords, etc. Articles used for the study were obtained from the SCOPUS

database since it has a broad interdisciplinary coverage, strong citation base, and extensive Meta data records, high compatibility with Biblioshiny, VOSviewer applications and is widely used in bibliometric studies (Baas *et al.*, 2020). The most important keywords used for retrieving the articles were "self-directed learning", "self-directed learning readiness", "e-learning", "digital learning" and their synonyms. "Self-regulated learning" was also used since many studies use the two terms interchangeably and individuals who have mastered self-regulation also exhibit self-directedness in learning (Balapumi and Aitken, 2012). Only articles in "English" language were included in the study to ensure consistency and comparability. The articles were also restricted to the domains of Social Sciences, Psychology and Management. Since SDL is primarily a learning and behavioral construct and the study is restricted to digital learning contexts, including all domains like Computer Sciences or Medicine or Engineering will retain studies that might be technological or clinical. The following search query was used to collect data from the Scopus database for the primary objectives, (TITLE-ABS-KEY ("self-directed learning" OR "self-directed learning readiness" OR "SDL readiness" OR "SDLR" OR "autonomous learning" OR "learner autonomy" OR "self-regulated learning")) AND (TITLE-ABS-KEY ("e-learning" OR "online learning readiness" OR "flipped classroom" OR "digital learning" OR "lifelong learning" OR "adaptive learning" OR "gamified learning" OR "micro learning" OR "blended learning")). For the secondary objective of the study that intends to focus on self-directed

digital learning and workplace relevance, further filtering was carried out with the following search query. (TITLE-ABS-KEY ("workplace learning" OR "employee training" OR "human resources" OR "organizational learning" OR "corporate learning" OR "professional development" OR "workforce development").

The study has followed the PRISMA framework Tables 1 and 2 to ensure the study remains transparent, structured and the results remain relevant. The PRISMA framework is widely used to enhance methodological clarity (Liberati *et al.*, 2009; Page and Moher, 2017) also find that the framework is gaining relevance since it improves the reporting quality across evidence synthesis and review methodologies Ozturk *et al.* (2024) in their study also recommend the usage of the PRISMA framework in bibliometric studies.

Figure 1 captures the overall process followed by incorporating the PRISMA framework to ensure authenticity and relevance.

The data was collected from the SCOPUS website on 31 January 2026. Data used for the study spans from 1978 to 2025. The use of a single database however, gives the study limitations related to database coverage, language bias, and indexing selectivity. Also, studies that have been solely indexed by any other database other than SCOPUS may not be represented in the present study. Also, the study findings depend on the search items and inclusion criteria which may have influenced the scope of the reviewed literature. The data gathered from SCOPUS was subjected to various analyses in VOSviewer (Van Eck and Waltman, 2010)

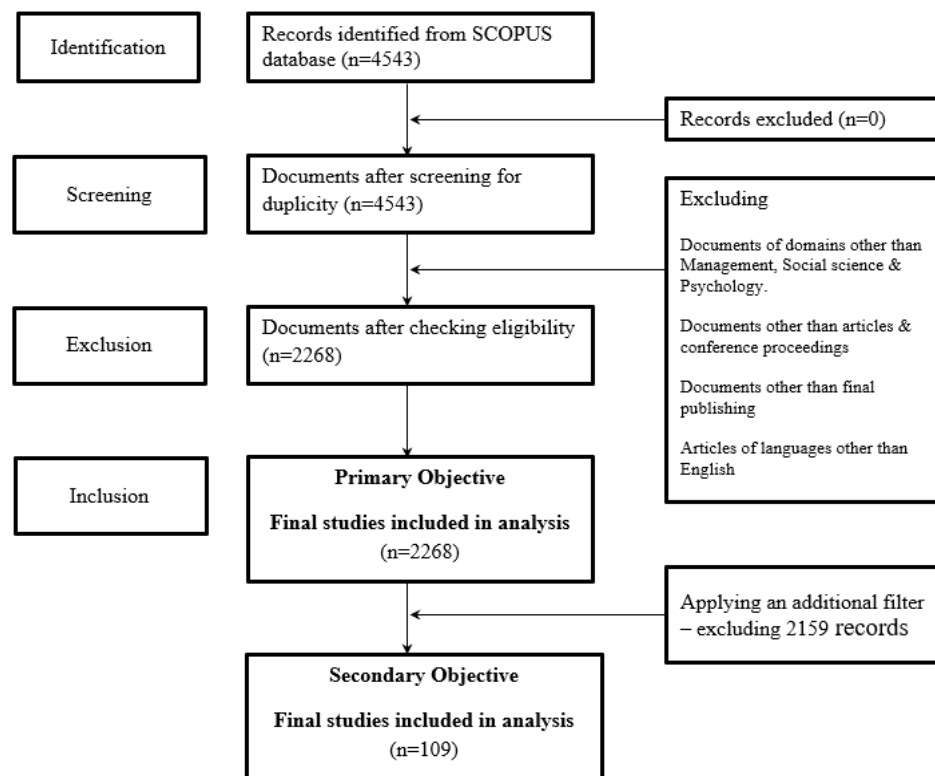


Figure 1: PRISMA Flowchart.

and Bibliometrix R package and its web interface Biblioshiny (Aria and Cuccurullo, 2017) to serve the study objectives. The visualizations generated by the software applications were further interpreted to understand the thematic evolution conceptual linkages within the literature.

RESULTS AND DISCUSSION

RQ1a. How has research about Self-Directed Learning (SDL) within digital learning contexts evolved over time?

Evolution of research in Self-directed learning in the context of Digital Learning

Figure 2 traces the evolution of this topic with time. It can be seen that very few research studies have been published before 2005, suggesting limited scholarly attention towards Self-Directed Learning (SDL) in those years. Research in SDL in an online/digital context started to increase steadily between the years 2003 and early 2019. After 2019, there is evidence of exponential growth, possibly triggered by the Covid pandemic, with the number of publications attaining a new peak in 2025 with more than 300 documents. This continued growth shows the increasing recognition of self-directed learning as essential competencies in technology-driven, and lifelong learning environments (Dhawan, 2020).

RQ1b. What has been the impact of the Pandemic on the SDL research in digital learning contexts?

Figure 3 is a thematic evolution map generated by Biblioshiny, a web-based interface for bibliometric analysis. In order to understand the evolution of the said theme and also analyse the effects of Covid-19 on the same, the present study has used the following time slices, 1979-2019, 2020-2020, and 2021-2025. The findings have been interpreted based on the three time periods.

Table 1: PRISMA Stages for Primary Objective.

PRISMA Stage	Primary Objective
	Count
Records identified (1979 -2025)	4543
Duplicates removed	0
Records limit to Sub (Social Sciences, Psychology, Management)	2793
Limit to Doc Type (articles, conference type)	2403
Limit to Publishing stage (final)	2361
Limit to source Type - Journal + conference proceeding	2350
Limit to English	2268
Records screened (title/abstract)	2268
Records excluded	-
Final studies included in analysis	2268

Source: Generated by authors.

Documents by Year

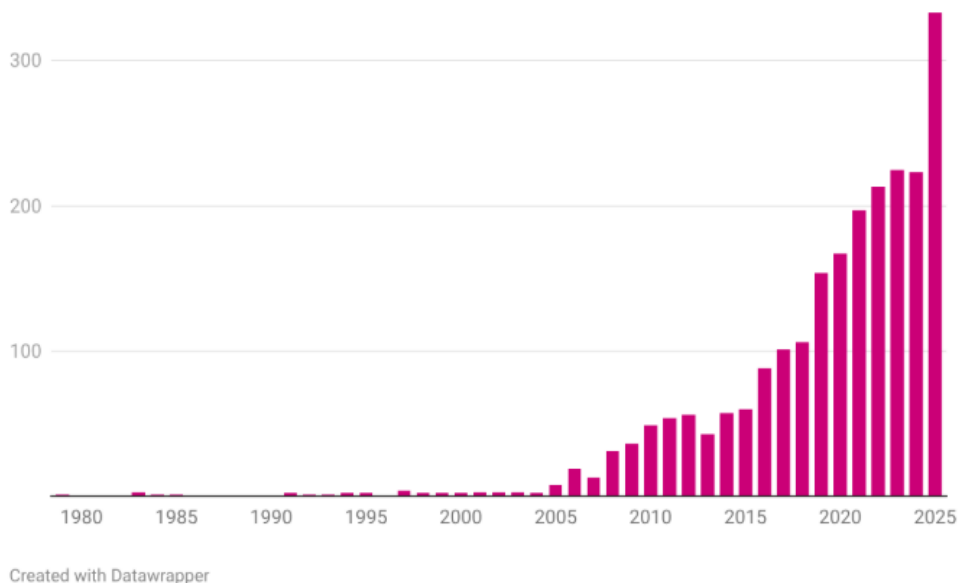


Figure 2: Documents by Year. Source: Author generated in Datawrapper.

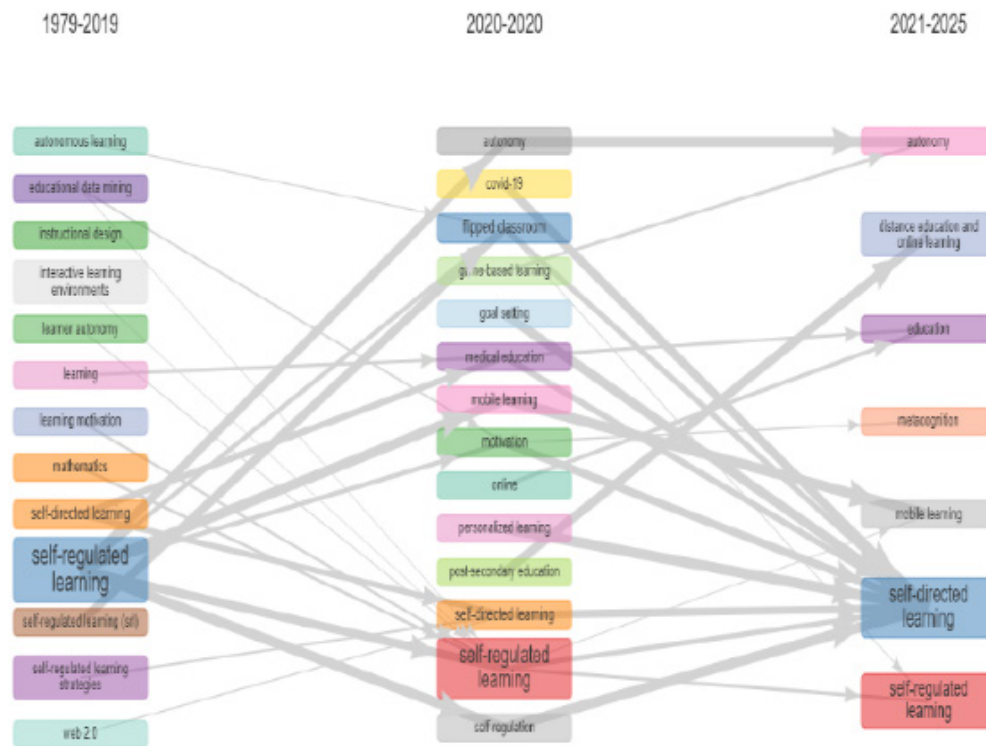


Figure 3: Thematic Evolution Map with 3 Time slices. Source: Image generated through Biblioshiny.

Period 1: 1979 - 2019

The said period can be called the foundational period; hence, it shows a broad range of topics that explain the context of SDL. The major/dominant themes of this period include, "Self-regulated learning", "self-regulated learning strategies," "Autonomous learning." The other prominent themes as shown in Figure 3, are "educational data mining," "instructional design," "interactive learning environments," and "learner autonomy". These key topics set the context of the SDL phenomenon. These themes are central to the concept of self-regulated learning and therefore continue to remain relevant across different time periods (Zimmerman, 2002).

Period 2: 2020-2020

The year 2020 marks the transitional and transformational period in SDL research. It also marks the year when the pandemic had hit the world and online/e-learning had taken over the learning landscape. With every institution and organization forced to move their learning online, learning became an individual concern, and research about SDL, especially in the context of online/e-learning, began to grow exponentially (Hodges *et al.*, 2020). Hence, this particular time period shows the emergence of new influential themes like "Covid-19," "Online," and "mobile learning". "Flipped classroom," "game-based learning," and "personalized learning" are also seen as key topics, suggesting a

move towards more adaptive educational models (Shamir-Inbal and Blau, 2022). From Figure 3, it can be seen that "autonomy" emerges as a standalone topic predominantly talked about in research articles in the time period. The connections represented by the arrows in Figure 3 also show how the topics "self-regulated learning" and "learning" are directly connected to the pandemic-induced topics like online learning, "mobile learning", "flipped learning".

Period 3: 2021-2025

The time period ranging from 2021 up to 2025 shows the consolidation and the bigger picture of the research landscape. "Self-directed learning" emerges as the most prolific theme followed by self-regulated learning. This finding aligns with those of other notable studies (Rini *et al.*, 2022; Rodriguez-Gomez *et al.*, 2024). In this time slice, themes like "Distance education and online environments" have evolved as one major theme (Ng *et al.*, 2023). "Autonomy" and "Mobile learning" continue to be prominent themes in this time period too (Hwang and Fu, 2019). A significant finding is the emergence of "Metacognition," which shows that many researchers started to focus on the metacognition theory of SRL (Schraw and Dennison, 1994). The direct flow of arrows from topics like "mobile learning", "personalized learning", "medical education", "Covid 19", "motivation", "goal setting", "game-based", "flipped classroom"

from time period 2 to “self-directed learning” in time period 3 shows that research about SDL gained prominence and expanded immensely. The time slice 3 that shows the improved significance of self-directed learning among the other themes illustrates how the temporary crisis (Covid19) accelerated and solidified SDL research trajectory (Van *et al.*, 2021).

RQ2. What are the dominant and emerging keywords and themes in the context?

To serve this research Question, Co-occurrence analysis was conducted in VOSviewer followed by Thematic Map generation in Biblioshiny to identify Niche, Motor, Emergent/Declining and Basic themes within the research context.

Keyword Co-occurrences Analysis using VOSviewer for Themes identification

Keeping the minimum number of occurrences as 25, out of 4870, only 40 met the threshold. However, on the basis of the total strength of co-occurrence's link, only keywords with greater link strengths were selected. As shown in the network visualization, i.e. Figure 4, three clusters emerged. The clusters are shown in Table 3 followed by the detailed discussion.

Theme interpretation

Cluster 1 as shown in Table 3 primarily refers to research that is focused on SDL and its application in online, mobile, blended, flipped and collaborative learning environments. The cluster also includes keywords like motivation, learner autonomy; metacognition and Self-regulated learning which indicate that contemporary research increasingly considers these individual factors as determinants of effective digital learning. These keywords also are related to the conceptual foundation of SDL. Studies by Chen and Hung, (2025) also document possible connections between SRL and motivation of students and enhanced learning in flipped classroom pedagogy. It should be noted that though SDL and SRL have different theoretical origins, they are closely related. Both the constructs are learner dependent and are crucial in digital and autonomous learning contexts (Saks and Leijen, 2014; Jossberger *et al.*, 2010). While SDL places importance on learner ownership of the learning process, SRL focuses more on the regulation of cognitive, motivational, and behavioral learning strategies. Nevertheless, both constructs share common dimensions such as learner autonomy, metacognition, self-management, and goal-oriented learning, particularly within online and technology-mediated learning environments. Loyens *et al.* (2008) also suggests that self-directed learning is broader and encompasses self-regulated learning and both the constructs are similar since they both place greater importance on the concept of “self-learning”.

Cluster 2 includes keywords that refer to the contexts where SDL plays a crucial role. For instance, in adult and distance learning and among medical professionals. This suggests that

SDL research has historically gained stronger traction in learning environments that are dependent on constant knowledge updates, independent and autonomous learning. Study by Hamori (2023) finds that SDL is more pronounced in distance learning. Sande and Rajguru (2025) also find that effective learning can happen by integrating SRL through case study-based teaching in medical students. Collectively, the cluster reflects the growing recognition of SDL and SRL as foundational capabilities within professional, high-stakes, and lifelong learning ecosystems.

Cluster 3 includes keywords that are mostly related to new-age dimensions like artificial intelligence and computer-aided education, where concepts like SDL and SRL are gaining more importance (Holmes *et al.*, 2019). The emergence of these keywords indicates the growing importance of integrating self-regulatory capabilities within emerging educational technologies to ensure meaningful and effective learning outcomes Čakane *et al.* (2025) in their study identify ICT integration, self-regulated learning, and deep learning approaches as essential components for achieving quality learning in digital education models. Collectively, the

Table 2: PRISMA Stages for Secondary Objective.

PRISMA Stage	Secondary Objective Count
Records identified (from Objective 1 dataset)	2268
Additional Filter applied - TITLE-ABS-KEY(("Self-directed learning" OR "self-directed learning readiness" OR "SDL readiness" OR "SDLR" OR "autonomous learning" OR "learner autonomy" OR "self-regulated learning") AND ("E-learning" OR "online learning readiness" OR "flipped classroom" OR "digital learning" OR "lifelong learning" OR "adaptive learning" OR "gamified learning" OR "micro learning" OR "blended learning")) AND PUBYEAR > 1978 AND PUBYEAR < 2026 AND (TITLE-ABS-KEY("workplace learning" OR "employee training" OR "human resources" OR "organizational learning" OR "corporate learning" OR "professional development" OR "workforce development")) AND (LIMIT-TO (SRCTYPE, "j") OR LIMIT-TO (SRCTYPE, "p")) AND (LIMIT-TO (PUBSTAGE, "final")) AND (LIMIT-TO (SUBJAREA, "SOCI") OR LIMIT-TO (SUBJAREA, "PSYC") OR LIMIT-TO (SUBJAREA, "BUSI")) AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "cp")) AND (LIMIT-TO (LANGUAGE, "English"))	109
Duplicates removed	0
Records screened (title/abstract)	109
Final studies included in analysis	109

Source: Generated by authors.

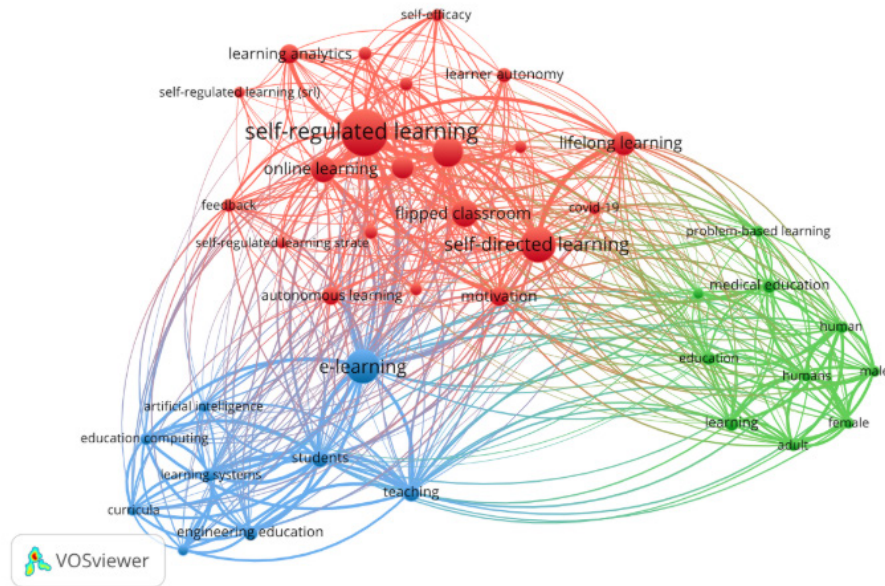


Figure 4: Keyword Co-occurrences Analysis - Network Visualization. Source: VOSviewer.

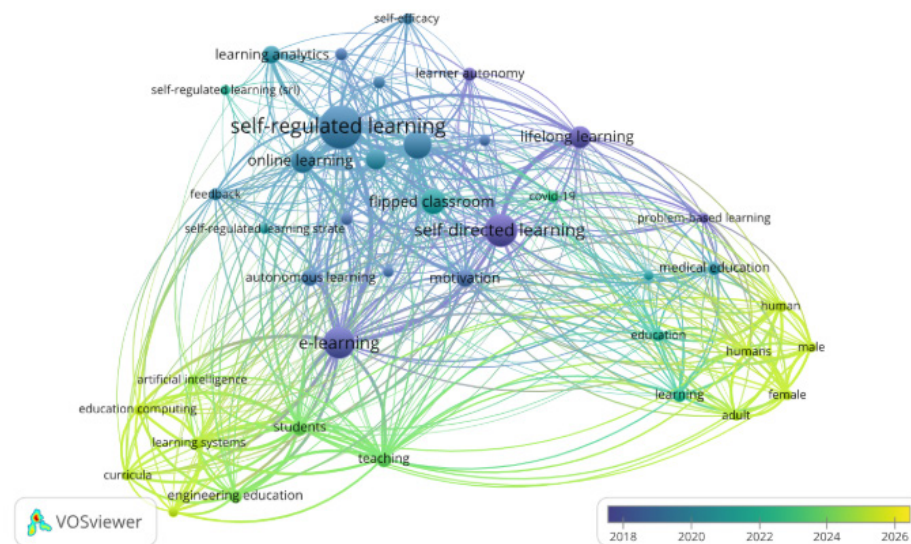


Figure 5: Keyword Co-occurrences Analysis - Overlay Visualization. Source: Image generated through VOSviewer.

findings suggest that concepts like SDL are becoming central to the effective functioning of technology-intensive learning environments.

As shown in Figure 5, which displays the overlay visualization, it can be understood that studies related to SDL until 2019 dealt with the foundations of the theme. The terms like motivation, lifelong learning, autonomy, and distance education were studied in relation to SDL (Schunk and Greene, 2018). Most of the studies were related to the field of medical education (Wiljer *et al.*, 2018).

After 2019, however, the concept was studied more in connection to the context of artificial intelligence, education with the aid of technology (Zhao *et al.*, 2024), and the emergence of studies related to engineering education. Post pandemic, the concept has been more discussed in studies in relation to COVID-19, digital learning, flipped learning, and artificial intelligence (Bond *et al.*, 2021). Collectively, this trend indicates that SDL research has evolved from a predominantly pedagogical construct toward a broader technology-integrated and digitally adaptive learning paradigm.

While VOSviewer helps to identify the major themes through keyword co-occurrence analysis, the present study has used the thematic map in Biblioshiny to classify the themes into niche, emerging/declining, basic, and motor themes based on their relevance (Aria and Cuccurullo, 2017). This analysis can help researchers identify future research directions.

Thematic Analysis using Biblioshiny to identify Major themes

As shown in Figure 6, the basic themes related to SDL and SRL are lifelong learning, self-efficacy, and metacognition (Fong *et al.*, 2023). Most of the SDL-based research was done in medical education. It can be seen that blended learning, motivation, and learner autonomy are in the quadrant that represents emerging/declining themes. Though they are relevant to SDL research their positioning shows that their development trajectory remains uncertain. They could be declining or emerging. However, this suggests that future research should investigate into how motivational and autonomous learning processes evolve in contemporary digital learning ecosystems. Furthermore, it is seen that concepts like e-learning, autonomous learning, collaborative and mobile learning are in the niche area, suggesting that they are well-developed, but studies regarding these themes are isolated. Finally, the themes like online learning, higher education, and COVID-19 are in the motor region, indicating that these are the trending themes that are being majorly researched and are gaining traction. Figure 5, which displays the overlay visualization using VOSviewer, also supports the fact that these themes are discussed more frequently in recent studies.

RQ3. Which authors, organizations, journals, and Countries have significantly contributed to research related to SDL in digital learning contexts?

Productivity Analysis using VOSviewer

Based on the results displayed in Table 4, the author with the most number of citations is Mar Pérez- Sanagustín. The author has produced seven documents, with most of his works focusing on self-regulated learning strategies. Mar Pérez- Sanagustín's works mostly highlight SRL strategies like goal attainment that help learners in MOOC-based learning environments. The author's other works also concern the usage of learning analytics and other digital techniques to support SRL in digital learning environments. From Table 4, it is also evident that the most productive author based on documents is Tsai Chia-Wen. The author has produced 20 documents about self-regulated learning. His study, "Developing an Appropriate Design of Blended Learning with Web-Enabled Self-Regulated Learning to Enhance Students' Learning and Thoughts Regarding Online Learning" published in the journal "Behaviour and Information Technology" shows that when school students in Taiwan were subjected to web-enabled self-regulated learning in online

blended classes, their performance was better than the students in the control group. The author's works are mostly related to self-regulated learning in an online learning context, which in turn results in better learning outcomes.

Table 5 captures the most significant articles related self-directed learning in the context of digital learning. These are the most influential works that have contributed immensely either by producing scales to measure the construct(s), providing methodological anchors, and shaping the research landscape in the said context. It is to be noted that few studies, though influential with respect to their contribution, have 0 link strength, indicating that they do not fit into an integrated research cluster. These can be works with niche themes or even concerned with a specific domain like medical or nursing education, like in the case of Srinivasan (2007).

Based on the findings listed in Table 6, the country with the maximum citations for its articles on self-directed learning in digital context is the United States, followed by Taiwan. Despite this, there is limited evidence regarding the integration of the same in educational policies. China has however, taken steps

Table 3: Keyword Clusters/ Themes identified using VOSviewer.

Cluster 1	Cluster 2	Cluster 3
Active learning	Adult	Artificial intelligence
Autonomous learning	Distance learning	Computer aided instruction
Blended learning	Education	Curricula
Collaborative learning	Female	E-learning
Covid-19	Human	Education computing
Feedback	Learning	Engineering education
Flipped classroom	Male	Learning systems
Higher education	Medical education	Students
Learner autonomy	Problem-based learning	Teaching
Learning analytics		
Lifelong learning		
Metacognition		
Mobile learning		
Motivation		
Online learning		
Self-directed learning		
Self-efficacy		
Self-regulated learning		

Table 4: Top 10 Authors by Citations produced.

Author	Documents	Citations	Total Link Strength
Pérez- Sanagustín, Mar	7	1317	50
Gašević, Dragan	16	1099	82
Broadbent, Jaclyn	5	744	30
Baars, Martine	7	670	35
Wong, Jacqueline	6	666	35
Tsai, Chia-wen	20	564	108
Pardo, Abelardo	5	451	33
Liaw, Shu-Sheng	5	441	4
Shen, Pei- Di	12	438	89
Kester, Liesbeth	5	437	14

Source: Table generated by authors.

Table 5: Top 10 Documents based on Citations.

Document	Citations	Links	Contributions/Findings
Kizilcec(2017)	725	3	Self-Regulated Learning (SRL) strategies play a greater role in resulting in better learning outcomes. Especially goal setting and strategic planning predicted learning goal attainment. Individual learners' characteristics determined their Self-regulated learning levels.
Barnard (2009)	656	66	Development and validation of Online self-regulated learning questionnaire
Hung (2010)	621	22	Development and validation of an instrument for online learning readiness scale for college students with self-directed learning as a sub scale
Gasevic (2016)	547	0	A generalized model of learning analytic indicators cannot predict academic success. The outcome highly differs based on way in which students engage with technology and learning management systems. Learners with high Self-regulated learning may engage with LMS strategically and not continuously. This in turn predicts their academic success.
Broadbent (2017)	498	34	Time management and Elaboration strategies were found to be the most important Self-regulated learning strategies for both online and hybrid learning modes.
Littlejohn (2016)	448	37	The study finds that there exists considerable difference among learners with high Self-regulated Learning and those with low Self-regulated learning. The difference in their motivations and goals affect their perception of learning through MOOCS
Wong (2019b)	439	41	Self-regulated learning is more significant in MOOC learning environments since they require autonomous learning. The study found that human factors like gender, cognitive abilities, prior knowledge determine effectiveness of Self-regulated learning strategies
Srinivasan (2007)	350	0	Medical students and faculty preferred case based learning over problem based learning. But problem based learning was found to encourage Self-directed learning. However, the study did not find which method resulted in better physicians.
Paechter (2010)	331	4	In the context of E-learning, online classes are preferred by students since they support self-regulated learning skills.
Yilmaz (2017)	326	15	Students' e-learning readiness which also constitutes self-directed learning as a subscale, significantly predicted their satisfaction and motivation in Flip Class model of instruction. Students with high e-learning readiness are highly unlikely to lose motivation and satisfaction in flipped class setup.

Source: Table generated by Authors.

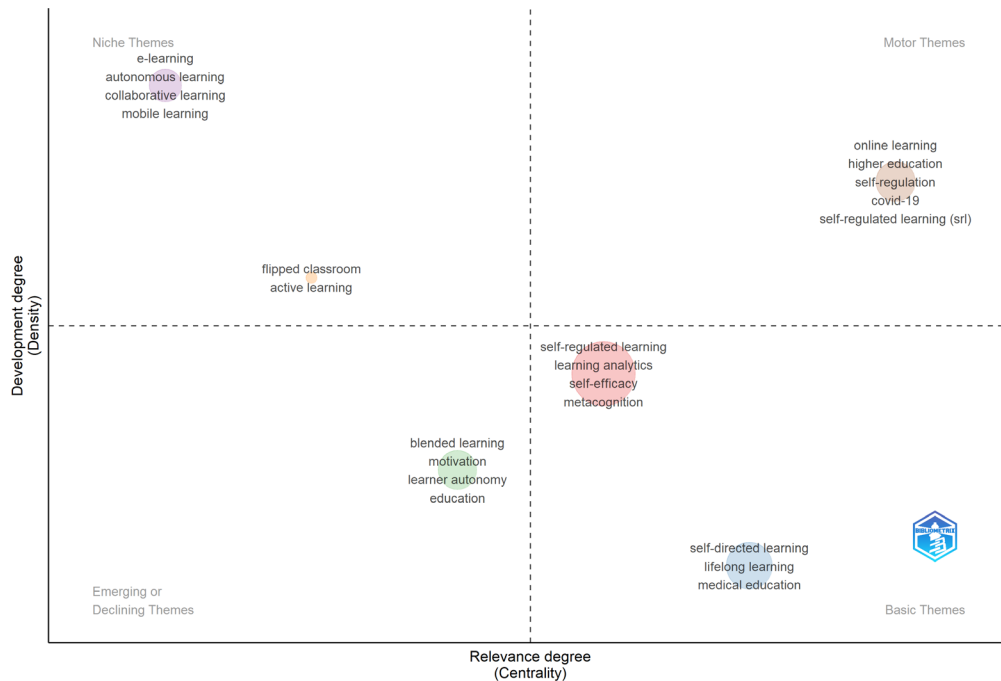


Figure 6: Thematic Map using Biblioshiny to identify Major themes. Source: Image generated through Biblioshiny

to revamp their curriculum standards to emphasize learner autonomy and self-regulation (Shahzad *et al.*, 2024).

Author Productivity by Documents

Figure 7 lists the most significant authors involved in the said research context. The top three authors who have contributed to advancement of learner autonomy in digital learning environments are Tsai Chia-Wen, Dragan Gasevic and Inge Molenaar. Tsai Chia-Wen, currently at Ming Chuan University, has authored research works related to blended learning pedagogy explains how learners actively direct and regulate their learning through goal setting, strategy formulation, self-monitoring and self-evaluation thereby assuming responsibility of the learning process. Molenaar's research related to adaptive learning environments shows the importance of feedback mechanism to support autonomous learning. His works iterate that in the absence of proper feedback mechanism, goal setting and self-evaluation alone may not generate accurate regulatory actions. Gasevic Dragan's studies on the other hand throw light on learners' digital footprints can be used to understand and support self-regulatory behaviors in online learning environments. Collectively their works suggest that effective learning in digital learning environments depend not only on learner's autonomy but also on the ability to monitor, evaluate, interpret feedback and adapt learning strategies. These findings reinforce that self-regulatory processes such as goal setting, motivation, feedback interpretation and self-evaluation are important. It is only through these mechanisms self-directed learning can be exercised and sustained in digital learning environments.

Prolific Author Networks

In order to identify and explore the various significant authors in the SDL research context, co-authorship and co-citation analyses were carried out, and the results are discussed as follows.

Co-authorship Analysis

This analysis is to identify the most significant author networks in the said research context. The co-authorship analysis, as shown in Figure 8, indicates that there are 4 prominent networks. These networks were obtained by setting the threshold for minimum number of documents per author as 5 and minimum citations as 0. Out of the 65 authors who met the criteria, only 19 were connected. The most closely knit author network represented by the red cluster includes Inge Molenaar, Maria Bannert, Joep van der Graaf, Lym Lin, Mladen Rakovic, and Yizhou Fan. Table 7 shows that the most influential author with the highest Total Link Strength (TLS) is Dragan Gasevic with 17 documents and a TLS of 62. The author acts as a bridge between the three clusters. The second most influential author is Inge Molenaar with 13 documents and a TLS of 46, followed by Maria Bannert with 10 documents and a TLS of 49. The network led by Baars, Martine, Wong, Jacqueline, and Paas, Fred G W C is not integrated with the main network of authors indicating the presence of highly specialized research streams that are not related to dominant themes in the SDL research.

As shown in Figure 9, the overlay visualization highlights that authors such as Inge Molenaar, Yizhou Fan, Lim, Lyn, Shaveen Singh, Nguyen, Andy, and Jarvela, Sanna M, and Joep Van Der Graaf have emerged as key contributors to self-directed learning research in the post-2022 period. Their studies reflect the recent

shift toward exploring data-informed and technology-enhanced approaches to self-directed and self-regulated learning. This overlay visualization illustrates how the focus of SDL research is evolving in response to advances in digital learning environments and learning analytics.

Author Co-citation Analysis

The authors' co-citation analysis was conducted to identify the intellectual structure as well as map the evolution of the theme. The most prominent cluster in red, as seen in Figure 10, comprises Anthony R. Artino, Robert M, Robert A, Butler, Bernacki and, David J. Their studies represent self-regulated learning practices grounded in educational psychology. The green cluster, led by Barry J Zimmerman, Paul R Pintrich, Andrew J, Deci, Davis, and Kzilcec RF, have authored studies based on the Social Cognitive theory and self-determination theories that place importance on self-efficacy, motivation and the interactions between the learner and the learning ecosystem. Their studies provide the theoretical basis and explanation for how learner attributes like self-efficacy helps to regulate and sustain their learning process in digital or technology mediated environments. The blue cluster represented by the studies of De Azavedo J C S, Vincent Aleven and Charlotte C, are related to digital learning environments that examine how intelligent learning systems support autonomous learning. The strong links connecting all three clusters show that contemporary research is increasingly integrating cognitive, motivational and technology perspectives to explain and predict learners' behaviour in digitally mediated ecosystems.

RQ4. How research about SDL within digital learning context has been integrated with themes like employee development, organizational learning, and human resource development in digital learning environments?

To address the above-mentioned research question, keyword co-occurrence analysis was conducted in VOSviewer followed by the generation of a thematic map using Biblioshiny. Keeping the threshold for the minimum number of co-occurrences as 5, out of 773 keywords, 34 keywords were obtained that have been represented by the three clusters.

The network visualization given in Figure 11 shows 3 highly interconnected research streams through which SDL has been integrated with professional and organizational learning contexts.

The red cluster includes terms like professional development, medical education, lifelong learning, clinical competence, medical student, and continuing professional development. This cluster highlights the dominance of self-directed learning in healthcare sector, where continuous and lifelong learning is believed to enhance the competency of the healthcare professionals (Mann *et al.*, 2020).

The green cluster primarily includes words like e-learning, self-regulated learning, teacher professional development, engineering education, Human Resource Management (HRM), and learning systems. The presence of HRM alongside self-directed learning and professional development shows that it is being considered as a strategic capability for workforce development in digitally mediated learning environments (Trust and Whalen, 2020).

Documents by author

Compare the document counts for up to 15 authors.

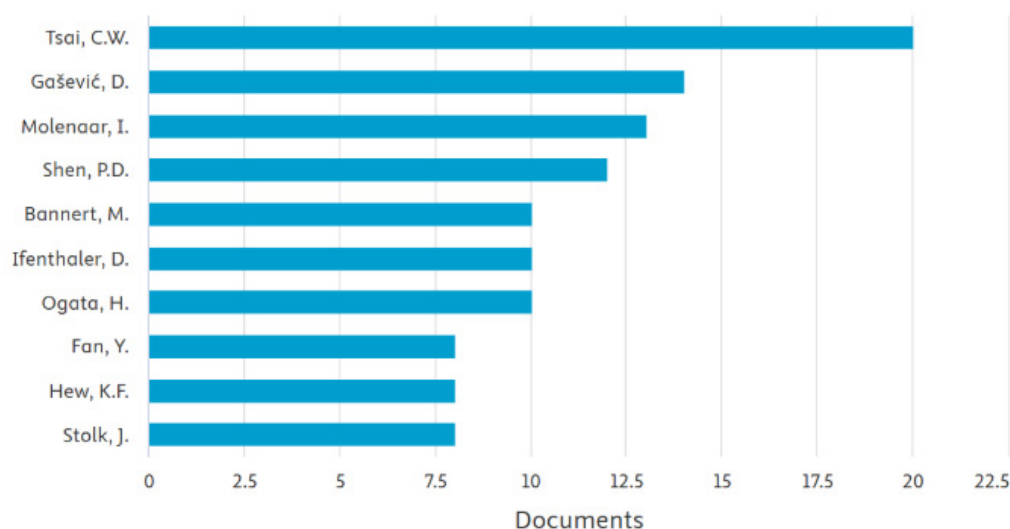


Figure 7: Top 10 Authors based on Productivity. Source: SCOPUS Website

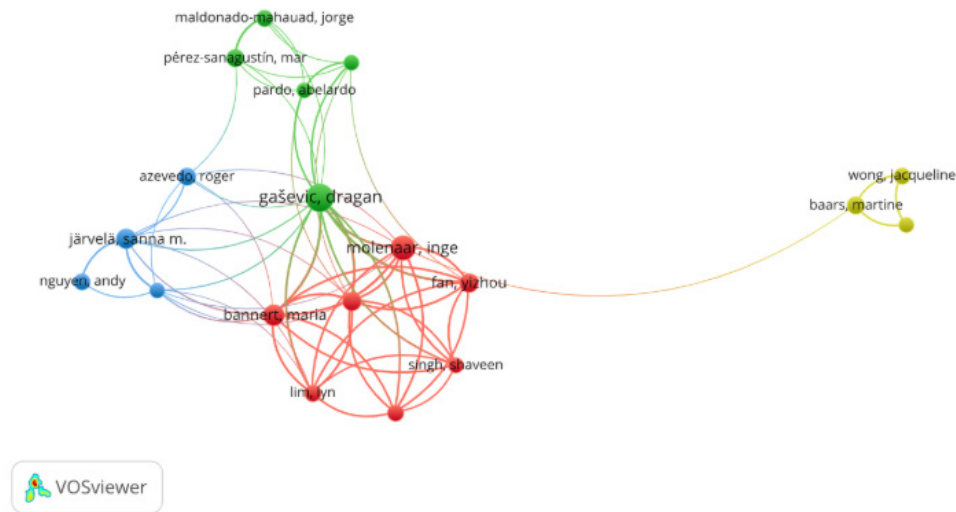


Figure 8: Network Visualization for Co-authorship analysis. Source: VOSviewer.

Table 6: Top 10 Countries based on Citations.

Country	Documents	Citations	Total Link Strength
United States	330	11744	603
Taiwan	169	5487	433
Australia	138	5074	454
United Kingdom	117	3325	243
Netherlands	79	3304	276
China	353	2681	324
Germany	148	2493	196
Canada	71	2099	87
Malaysia	109	1897	230
Turkey	62	1665	124

Source: Table generated by Authors.

The blue cluster includes words like self-directed learning, distance learning, COVID-19, and workplace learning. The emergence of self-directed learning and workplace learning shows that SDL research is no longer confined to educational settings and is increasingly being investigated in organizational contexts. The presence of Covid 19 suggests that the phenomenon has adequately affected and transformed self-directed learning-based research (Hamori, 2023; Van *et al.*, 2021; Lejeune *et al.*, 2021).

Overall, the central placement of SDL and its connectivity with themes like professional development, e-learning, self-regulated learning; workplace learning suggests that it is acting as an integrative mechanism between all these major contexts. The findings suggest that SDL as a construct is gaining significance in organizational learning contexts.

The overlay visualization in Figure 12 shows that the most trending keywords include self-regulated learning, COVID-19, continuous professional development, skills, and workplace learning. The most recent studies have dealt with these topics. The notable insight from the analysis is that recent research is integrating workplace learning with self-regulated learning, learning analytics, skill updations and digital learning environments rather than with the much broader concept of SDL.

Furthermore, in order to classify the themes as basic, niche, emerging/declining, or motor, the present study generated a thematic map using Biblioshiny. Figure 13 shows the same, and the findings are discussed below.

According to the Thematic Map, it can be understood that SDL, lifelong learning, continuous professional development, and learning analytics are the basic themes that explain learning in

organizational settings (Tannenbaum *et al.*, 2021). The themes like sustainability, online teaching, and higher education are emerging (Zawacki-Richter *et al.*, 2020) and represent new directions of research in SDL context. The niche themes, where research is advanced but still isolated, include classroom teaching, teaching/learning strategies, and pedagogies (Darling-Hammond

et al., 2020). The most trending themes in this arena include workplace learning, blended learning, e-learning, micro-learning, and teacher professional development indicate that organizations are leveraging these approaches for employee development (Hutasuhut *et al.*, 2021; Baber *et al.*, 2023).

Table 7: Authorship Network.

Author	Documents	Citations	Total Link Strength	Cluster
Molenaar, Inge	13	525	46	1
Bannert, Maria	10	436	49	1
Fan, Yizhou	8	509	42	1
Lym, Lin	6	269	39	1
Rakovic, Mladen	8	280	47	1
Singh, Shaveen	5	214	33	1
Van Der Graaf, Joep	6	274	35	1
Gašević, Dragan	17	1458	62	2
Pardo, Abelardo	5	488	10	2
Pérez-sanagustín, Mar	7	1418	10	2
Maldonado-mahauad, Jorge	6	1413	9	2
Matcha, Wannisa	5	268	11	2
Järvelä, Sanna	9	235	18	3
Azevedo, Roger	7	267	7	3
lämsä, joni	5	33	15	3
Nguyen, Andy	6	32	6	3
Pérez-Sanagustín, Mar	7	1418	10	4
Baars, Martine	7	748	11	4
Wong, Jacqueline	6	743	10	4

Source: Generated by authors.

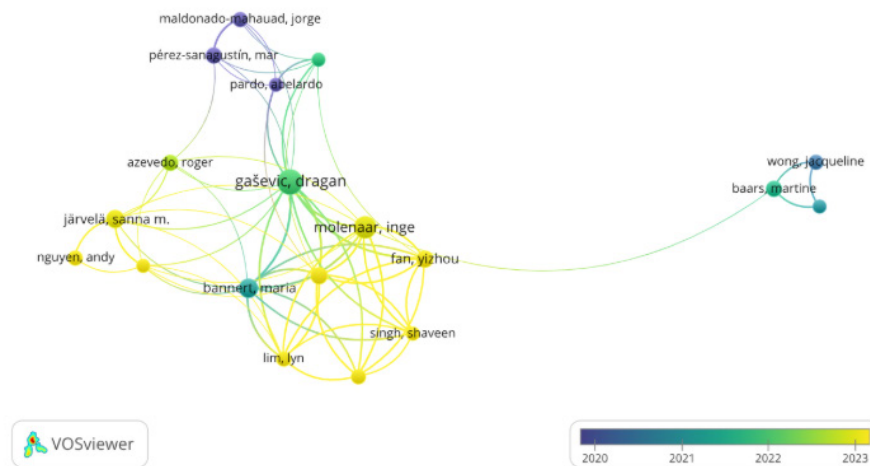


Figure 9: Co-authorship Analysis - Overlay Visualization. Source: VOSviewer.

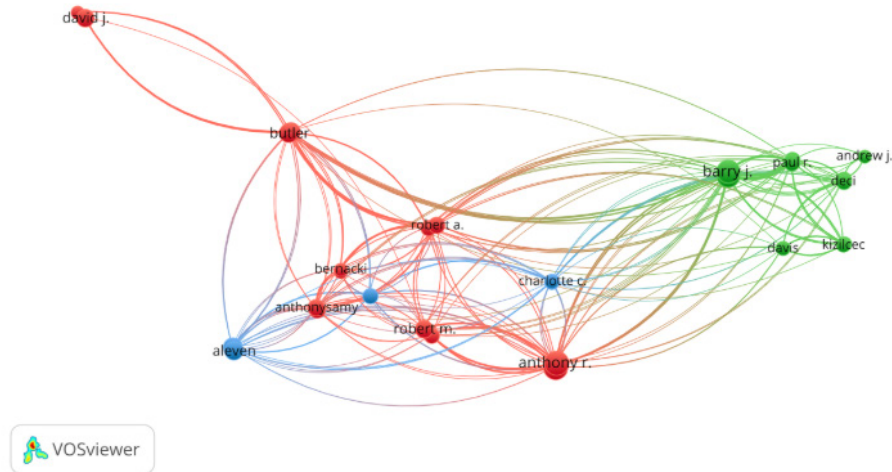


Figure 10: Author Co-citation Analysis - Network Visualization. Source: VOSviewer.

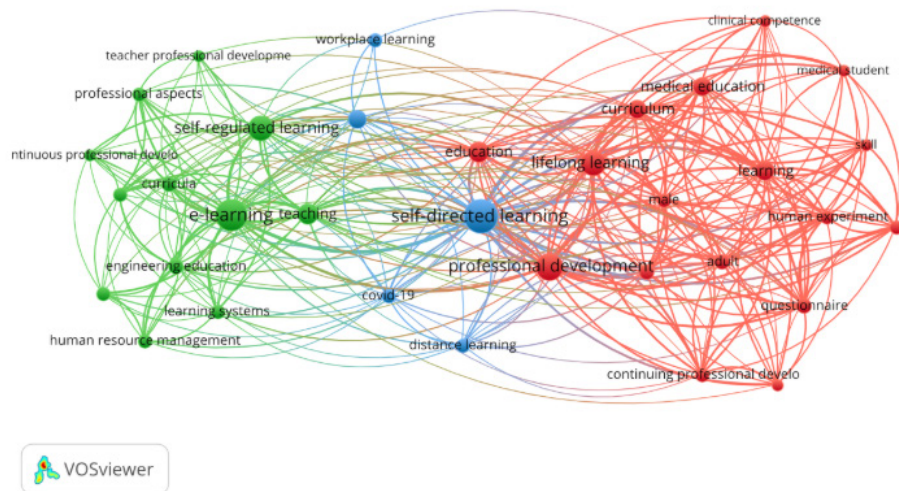


Figure 11: Keyword Co-occurrence Analysis - Network Visualization. Source: VOSviewer.

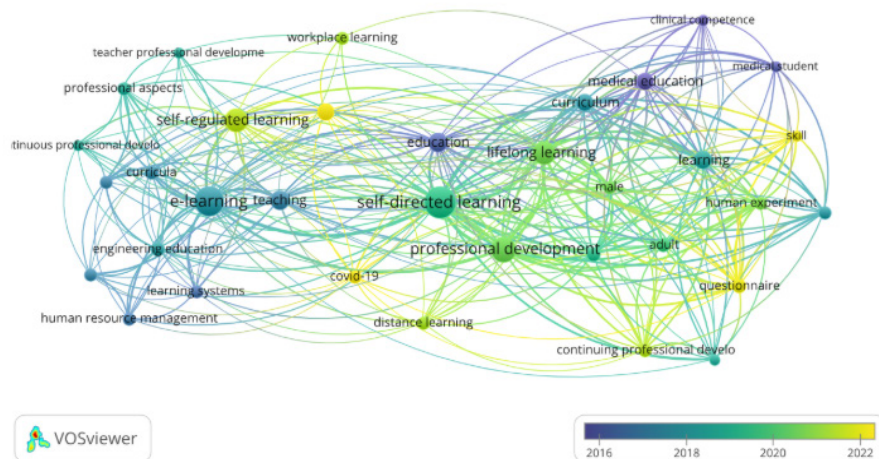


Figure 12: Keyword Co-occurrence Analysis - Overlay Visualization. Source: VOSviewer.

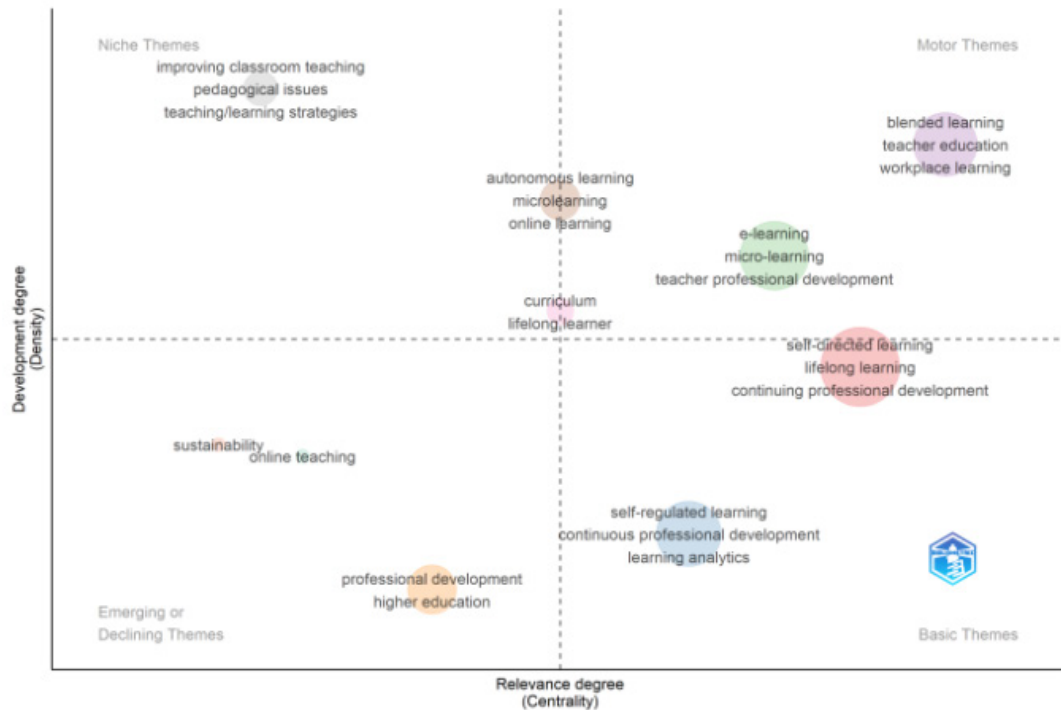


Figure 13: Thematic Map. Source: Biblioshiny.

Self-directed Learning (SDL) in Organizational and Professional Learning Contexts: Insights from Key Studies

To further investigate the RQ4, the most influential studies based on the citations were reviewed and presented below.

The study by Boyer (2014) which has emerged as the most work is a meta-analysis study related to self-directed learning that finds positive relatedness of the construct with internal locus of control, motivation, performance, self-efficacy, and support for effective workplace learning. These findings align with Campbell (2010) who also found that self-directed learning is central to competency-based Continuing Professional Development (CPD) model and promotes the role of assessment as a professional expectation and obligation. Similarly, Koukis (2019a) also finds that teacher engagement is an antecedent to learning and teaching effectiveness especially in tech enabled learning environments. Studies by Eaton (2020) and Dhillon (2020) also record that SDL contributes to professional development but in digital environments learner engagement is a crucial determinant of learning effectiveness. They also note that research in self-directed learning especially in professional development contexts is limited. Overall, the studies emphasize that SDL is crucial for professional development, lifelong learning and skills/competency development particularly for knowledge workers like teaching and medical professionals. Having said that the

studies also iterate that in digital learning environments apart from self-directed capabilities factors like learner motivation, engagement, digital literacy, technology readiness, and proper feedback mechanisms are also important without which the learning process can become ineffective.

LIMITATIONS AND FUTURE IMPLICATIONS

The present study employed a bibliometric research design that facilitates identification of thematic evolution, influential contributors and the existing research landscape. Such a study design is exploratory and may not capture the contextual depth and nuances of individual studies. Future research can therefore compliment the bibliometric findings through systematic literature reviews, content analysis or qualitative synthesis to uncover deeper insights into self-directed learning. Also, the present study finds that SDL is less researched in organizational settings despite the rapid digital transformation that is happening in the business world. Hence future researchers can take up empirical studies to understand the relevance of self-directed learning for professional development of human resources and its implications for the organizations.

FINDINGS AND CONCLUSION

The present study reveals a steady rise in research on Self-Directed Learning (SDL) particularly within the context of online and digital learning environments (Ng *et al.*, 2023). However, most studies

remain concentrated in the medical and teaching professions, where learning often occurs beyond formal classrooms and relies heavily on individual initiative and motivation (Van Alten *et al.*, 2020; Rini *et al.*, 2022). Emerging themes identified through Bibliometrix and VOSviewer analyses-such as online learning, mobile learning, and autonomous learning-reflect the increasing emphasis on self-driven educational approaches in digital learning environments. Ysuf (2023) also finds that in IT sectors, all employees engage in self-directed learning in digitally mediated learning environments that include usage of online platforms, video-based learning applications and social networking tools.

From a human resources standpoint, the analysis of literature connecting SDL with organizational outcomes highlights e-learning and continuous professional development as dominant themes. The central positioning of self-directed learning in the network mapping suggests that influential studies in this domain consistently underscore that higher levels of SDL lead to better workplace performance, adaptability, and continuous improvement (Noe *et al.*, 2017; Jansen *et al.*, 2019; Lejeune *et al.*, 2021).

Given the rapid transformation of today's work spaces, the study findings suggest that self-directed learning should be recognized as an emerging employability competency, much like critical thinking, creativity, or problem-solving. As workplaces increasingly demand adaptability and lifelong learning, the ability to direct and regulate one's own learning will become a defining trait of successful professionals. These are also consistent with the learning demands often associated with Industry5.0 (Carayannis and Morawska-Jancelewicz, 2022). This aligns with the findings of Chong (2018) and Vithayapom *et al.* (2021) that suggest that self-directed learning enhances the employability of individuals and hence, should be considered as an important skill in a 21st century workplace Lemmetty (2020) also states that self-directed learning especially in a technology dominated workplace is embedded into the job and improves individual's creativity, problem solving capability and agility. The study suggests that self-directed learning has many positive implications for both individual's professional development as well organization's competitiveness.

By mapping the theoretical evolution of self-directed learning research and identifying the major themes associated with it and its organizational relevance the present study extends existing bibliometric evidence by showing how self-directed learning has evolved from an educational construct into an essential capability in today's technology driven workspaces where lifelong, continuous and autonomous learning is the new mandate. The study also provides support for the theoretical evidence introduced in the study. The prominence of themes like self-efficacy, motivation, learner autonomy and self-regulated learning suggests the continued relevance of Social Cognitive

and Self-determination Theories. Similarly, the emergence of metacognition, goal setting, and self-regulated learning as dominant research themes suggests that successful learning in online and workplace contexts is dependent more on the learners' ability to take full accountability towards their own learning processes. These findings reiterate the theoretical proposition that learner agency, motivation, and self-regulatory capabilities are central to effective self-directed learning. Another notable contribution of the study is the prominence of self-regulated learning research in workplace learning context. This suggests that recent studies are placing more importance on learner's regulatory process, goal setting behaviours than on the broader concept of self-directed learning. The fact that countries like Taiwan are already reforming curricula to cultivate students' self-regulated learning capabilities highlights the construct's growing global importance (Coudenys *et al.*, 2022). Thus, the study urges educators and policy makers to come up with strategies to improve the self-directed and self-regulated learning capabilities of future workforce in order to build resilient learning organizations that can evolve with changing times.

ABBREVIATIONS

AI: Artificial Intelligence; **SDL:** Self-Directed Learning; **SRL:** Self-Regulated Learning; **TLS:** Total Link Strength; **HRM:** Human Resource Management; **CPD:** Continuing Professional Development.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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