

The Research Of Job Characteristics And Learning: Systematic Analysis Using Citespace And Histcite

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ABSTRACT

Purpose: Based on a systematic literature analysis using Citespace and HistCite, this study investigates the knowledge infrastructure hotspots and development trends of job characteristics and learning research.

Design/methodology/approach: The 864 publications from 1990 to 2023 that were obtained from the Web of Science database served as the basis for this investigation. This study explores the linkages and organization of knowledge of learning and job characteristics through the use of network analysis and bibliometrics.

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Research & Practical implications: Researchers can use the study as a reference guide to determine future research directions and the topics covered in earlier investigations. Using this research, practitioners can also discern overarching themes that could be integrated with contemporary research on job characteristics and learning.

Originality/value: This publication offers researchers a helpful reference guide to prior investigations, summarizing important features. An extensive summary of learning and work characteristics is provided by this study. Draws attention to the study field's development patterns and hotspots. The possible directions for further research are listed in light of the findings.

Keywords: job characteristic, learning, systematic literature review, Citepace, HistCite.

1. Introductory

The rise of the knowledge society and the quick changes in our surroundings have made workplace learning, or informal learning, more and more popular. Building a learning society and promoting lifelong learning have been valued by individuals and the state. Workplace learning is a type of learning that contrasts with formal education and is associated with the need for lifelong learning. Given this context, workplace learning research has exploded. While there are various ways to look at workplace learning, the majority of research focuses on individual workplace learning that is influenced by the office setting.

Workplace learning is directly impacted by job characteristics. To operationalize job characteristics, at least three models—JDC (Job demand-control) , JDCS(Job demand-control-support), and JDR(Job demand-resource) theory—are employed in workplace learning research. One of the most important models for studying work stress in service employees is the Job Demand Control (JDC) model(Gerards et al., 2020). The concept posits that job demands, which include time constraints and task needs, may exacerbate job strain. On the other hand, job control measures like decision-making power and work autonomy might lessen the pressure of the job (Taris & Kompier, 2005a; Decius et al., 2021; Decius et al., 2023; van der Baan et al., 2022)

To address the lack of human interactions in the JDC theory, which places a strong emphasis on job demand and control, the Job Demand-Control-Support (JDCS) model was proposed (Goller et al., 2020). Workplace learning is positively impacted by job support (Daniels et al., 2009). After enhancing the two Job characteristic models mentioned above, Bakker et al., (2010) proposed the JDR model and included it in research models of different workplace outcomes, such as workplace learning. They also added Job resources to enhance the meaning of Job characteristics further and expanded the definition of Job demand, Job support, and Job control (Parker & Grote, 2022; Parker et al., 2021; Gerards et al., 2020; Huo & Boxall, 2022; Susomrith & Coetzer, 2019). In addition to this, personal elements such as proactive personality (Parker & Sprigg, 1999; Martin et al., 2021; Van der Heijden & Spurk, 2019) are introduced into the explanatory model, thus explaining the differences in performance of different individuals with the same Job characteristic, which is more explanatory. From the existing literature, most of the studies on workplace learning from the perspective of workplace work have focused on this model or subdimension variable within the model to study workplace learning in depth.

It can be seen that the study of workplace learning from job characteristics has become a system and the literature is also very rich. There are studies on the impact of job characteristics on learning outcomes (Gerards et al. 2020; Glaser et al., 2015; Kittel et al., 2021; Naidoo-Chetty & du Plessis, 2021), such as the role of job demand, and its scopes such as (stress, workload, and psychological demand, etc.) on learning outcomes (Decius et al., 2021; Prem et al., 2017; Lin et al., 2018; Glaser et al., 2015), the roles of job resources, and their connotations (job autonomy, skill variety, leadership, feedback, social support) on learning outcomes (Gerards et al., 2020; Glaser et al., 2015; Ahsan et al., 2021), the study of job autonomy, skill variety, leadership, feedback, social support on learning outcomes (Decius et al., 2021; Lin et al., 2018; Vangrieken et al., 2023), and the study of job control on learning outcomes (Lin et al., 2018; Häusser et al., 2014). These indicate that Job characteristics play an important role in the process of learning.

The research literature on the relationship between job characteristics and learning is growing rapidly, and this field is developing rapidly. It is necessary to review the existing research status, trace the development trend of this field, explore the research conclusions and findings of existing literature, and predict the future development direction. In the past twenty years, there have been some literature reviews and studies on learning. Scholars have enriched learning and research from different perspectives and disciplinary backgrounds. For example, in 2005, Taris & Kompier (2005b) conducted a systematic literature review analysis on employee learning issues under the JDC model and found that although work characteristics have enlightening implications for learning, they did not form conclusive research conclusions. In 2010, Wielenga Meijer et al. (2010) reviewed 85 literature from 1969 to 2005 and identified the antecedents, process variables, and outcome variables of learning. They found a direct relationship between job demand and job autonomy and learning, and that the learning process affects learning outcomes. In addition to job characteristic elements, A systematic literature review for workplace learning (Kyndt & Baert, 2013) added personal factors such as goals, proactive behaviors, and psychological factors, among other elements. In 2020, Park et al. (2021) conducted a literature review on the influencing factors of learning, extracting antecedent variables (individual factors, group factors, organizational factors, work factors), mediating variables, moderating variables, and outcome variables, comprehensively presenting the various influencing factors of learning.

Although existing reviews suggest that Job characteristics have an impact on employee learning, a systematic literature review specifically addressing the relationship between Job characteristics and learning is still limited to 2005. In fact, after 2005, there has been an amount of research on Job characteristics and learning, but no systematic bibliometric studies on this topic, have been developed to grasp the vast history of the literature, research topics, experts in the field (country, author, institution, etc.), collaborative relationships between research authors and institutions, research hotspots (topic classification, viewpoint classification, etc.), and research trends (discovered research trends). To close this research gap, this article studied 864 articles from 1990 to 2023, identifying the highly cited (most influential) articles. Using bibliometric methods, explore the research status (countries, institutions, authors), research themes and their evolution, main research trends, keywords, theoretical model foundations and their evolution, and research hotspots. Finally, future development trends and implications were predicted.

This study uses a scientometric analysis based on CiteSpace to identify bibliometric characteristics and visualize relationships of articles in this field published in the journals of the Web of Science (WOS) between 1990 and 2023. The goal is to provide a systematic and objective overview of research on job characteristics and learning. The study is specifically directed by four main objectives: The objectives of this study are as follows: (1) to comprehend the nature of research collaboration in the field of job characteristics and learning; (2) to determine the most cited researchers, and journals in the field; (3) to depict the main knowledge groups and how they have changed over time in the field; and (4) to identify new areas of interest in job characteristics and learning. (5) Besides these, use HistCite software to screen the top 41 highly cited articles, by reading the top 40 highly cited articles, and the other two non-WOS library highly cited articles, plus the 20 highly cited articles after 2020, combined with the CiteSpace clustering results, to predict the research themes and research trends.

2. Materials and Methodology

2.1 Data Collection

Thomson Reuters's World Citation Index (WOS), which comprises the Science Citation Index Expanded (SCI-EXPANDED), Social Sciences Citation Index (SSCI), and Arts & Humanities Citation Index (AHCI) databases, covers about 12,000 prestigious journals globally and offers robust access to bibliographic data and citation data related to published research articles. It is widely regarded as the perfect data source for bibliometric studies. CiteSpace supports WOS export data for analysis. WOS data is very representative of the current state of research and cutting-edge direction of the topic and includes high-yield and high-level experts in the field.

On November 26, 2023, databases and data for the present investigation were taken from the internet WOS. The following were the most precise and effective keywords for data extraction: topic: ("Job characteristic?" or "work characteristic?" or "job design?" or "work design?" or "job demand?" or "work demand?" or "job resource?" or "work resource?" or "job support?" or "work support?" or "job control" or "job autonomy") and "learning". Books, editorial materials, and revisions were not considered in selecting the original pieces, which were solely published in English. In the end, 864 papers in plain text format were obtained, complete with referenced references for the scientometric analysis data supplement.

The data collection process and method can be seen in Figure 1. First, Citespace is used for network analysis, co-citation analysis, keywords analysis, and other analysis functions to reveal the information of the downloaded literature. It is a commonly used bibliometric software that can analyze the potential knowledge (Zheng et al., 2023). Then, Histcite was used to find highly cited articles from 864 articles, and its graph function was used to assist in extracting research topics, and finally the selected 63 articles were carefully read to analyze the research topics and knowledge.

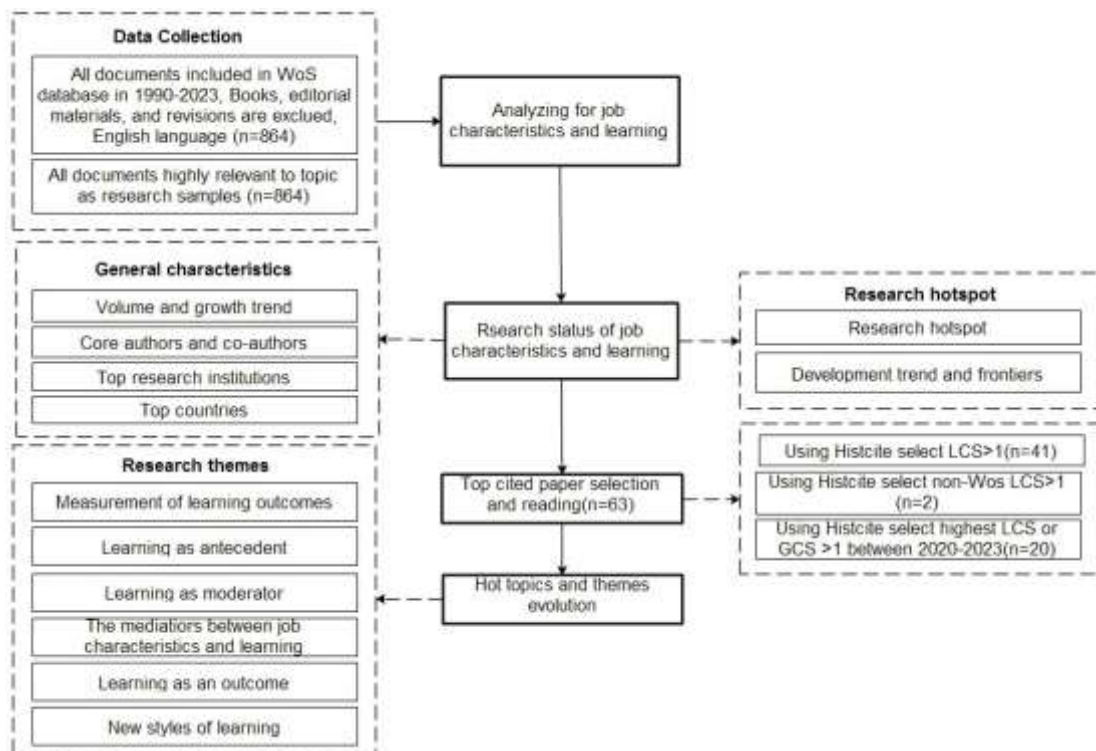


Figure 1 Processes and methods for data collection and analysis

2.2 CiteSpace

A scientometric program called CiteSpace is capable of producing knowledge domain visualizations. When comparing it to previous visualization tools, it has enhanced the readability and clarity of visualizations with a range of visual analytical features (Chen, 2017). It may specifically pinpoint the key ideas, turning points, landmarks, rising trends, and intellectual foundations of different publications within a group. CiteSpace can provide eight distinct visualization graphs to illustrate the patterns found in scientific publications. On the same screen, users can select the nodes, define thresholds, and define the time of the literature. The fundamental components of CiteSpace visualization graphs are nodes and linkages. Authors, organizations, nations, words, keywords, categories, cited authors, cited references, cited journals, grants, and articles are among the nodes. Papers in distinct time slices are shown by the concentric circles of distinct colors within a node. Links can also indicate different relationships within the underlying network. For instance, the color of a link indicates the year that two nodes first formed a relationship (for instance, the year that two authors collaborated in the context of the author collaboration network), and the thickness of a link indicates the

strength of that relationship (for instance, in the context of the journal co-citation network, the higher the journal co-citation count, the thicker the connection between two nodes).

2.3 HistCite

Eugene Garfield noted for his creation of the Web of Science (WoS) database and citation indexes for science, is the creator of the software package HistCite™ for bibliometric analysis and visualization. The software's launch procedure was changed in the following versions, Histcite™ pro 2.0 and 2.1, and an automated method for pulling raw data from the Web of Science was included (Wu & Tsai, 2022). According to (Garfield et al., 2005), the global citation score (GCS) indicates the frequency at which each paper is cited throughout the entire SCI, whereas the local citation score (LCS) is based on the number of citations inside the basic collection.

3. Data Analysis

3.1 Research Output

The development of published articles on learning and job characteristics over the last 33 years, from 1990 to 2023, is depicted in Figure 2. There is a discernible upward tendency over time, suggesting that scientific research plays a bigger part in job characteristics and learning. Three stages can be distinguished based on the growth curve of published papers:

Foundation period (1990-2009): Between 1990 and 2009, hardly a lot of literature was released. fewer than ten papers, alone. Still, it represents the foundational phase in the study of learning and job characteristics. Of the 864 highly relevant articles, 13 of the top 41 highly cited articles were published before 2009. Morrison & Brantner (1992) were the first to study the influences on job learning, in terms of job characteristics and personal factors, and all subsequent research in the field has been centered on either or both of these factors. The JDC model (job demand and job control) laid the cornerstone for subsequent learning research (Wall et al., 1996; Taris et al., 2003; Demerouti et al., 2001). In 1999, Parker & Sprigg (1999) proposed: Based on Job demand, Job control, and proactive personality, basically constructed a basic model for analyzing the influence factors of learning orientation outcome and proposed that the measurement of learning orientation outcome is divided into the following three dimensions: perceived mastery, role breadth self-efficacy, and production ownership. Other scholars share this view (Wang & Netemeyer, 2002; Taris & Kompier, 2004; Taris & Kompier, 2005); Besides JDC model, social interaction (Bond & Flaxman, 2006; Doornbos et al., 2008; Ouweneel et al., 2009; Daniels et al., 2009), and another individual aspect, the psychological flexibility are noticed by scholars (Bond & Flaxman, 2006). From the standpoint of occupational activities or organizational issues, it is evident that this literature provides a solid foundation for learning, even if fewer than ten publications were produced every year throughout this time.

Development phase (2010-2015): Some articles about learning and job characteristics had been written by this point. In these five years, 144 articles were published, which is more than in the previous twenty years. The JDCS model gave way to the JDR model during this time when it came to analyzing learning from the standpoint of job characteristics (Bakker et al., 2010). Besides this, personal factors, the learning goal; Kyndt et al., 2011; Kyndt & Baert, 2013; Maden, 2015), and motivation (Parker, 2014) have been the new research hotspots. Specific demands, such as change-related demand (Obschonka et al., 2012), Acceleration-related demands (Kubicek et al., 2013), or learning as a job demand (Kubicek et al., 2015; Korunka et al., 2015; Glaser et al., 2015) is emphasized. Then they make up for the deficiencies of the two models mentioned above.

Rapid development phase (2016-2023): Since 2015, the number of articles published has increased rapidly from 29 in 2015 to 136 in 2022. With the increasingly high social requirements for human resources, and the information society to improve the learning ability of talents, workplace learning has been increasingly emphasized, the concept of lifelong learning, the concept of workplace learning, and other concepts put forward, so that the study of workplace learning from the perspective of Job characteristics has become a hotspot for research in the academic community. These kinds of learning climate influence many proactive behaviors (Eldor & Harpaz, 2016). Learning as demand is popular in our society (Prem et al., 2017; Mauno et al., 2020; Decius et al., 2021). For individuals, learning is a goal when they are handling the work simultaneously (Zhang et al., 2017). Another hot research topic during this period was the impact of datafication on workplace learning, with an upward trend in the number of posts on the impact of various social software, data tools, etc. on learning (Parker & Grote, 2022).

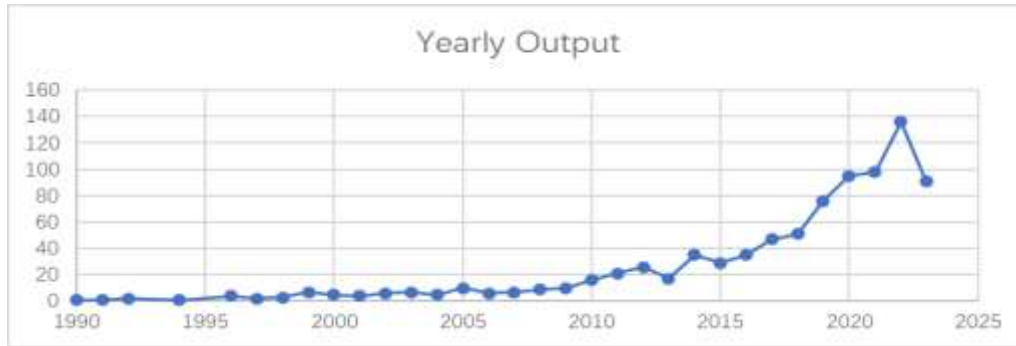


Figure 2 The Number of Published Papers on Job Characteristics and Learning (1990-2023)

3.2 Visualization of the Authors

631 authors contributed to the field of job characteristics and learning study. But the density is only 0.0029, It can be found that the authors show small-scale, small-group collaboration situations. Table 1 shows the top 10 authors based on frequency. Bakker and Taris are the leading researchers in this field and have been working in this area since 2010. According to the author collaboration network, represented by Taris and Kompier, Van Ruysseveldt, Mikkelsen, A, small groups of researchers have been formed, with collaborative relationships between them (see Figure 3).

Table 1 Top 10 authors based on frequency

Frequency	Year	Authors
9	2010	Bakker, Arnold B
8	2004	Taris, Toon W
5	2007	De witte, Hans
5	2004	Kompier, Michiel A J
5	2011	Van ruysseveldt, Joris
4	2021	Decius, Julian
4	2015	Korunka, Christian
4	2015	Kubicek, Bettina
4	2019	Matsuo, Makoto
4	1999	Mikkelsen, A

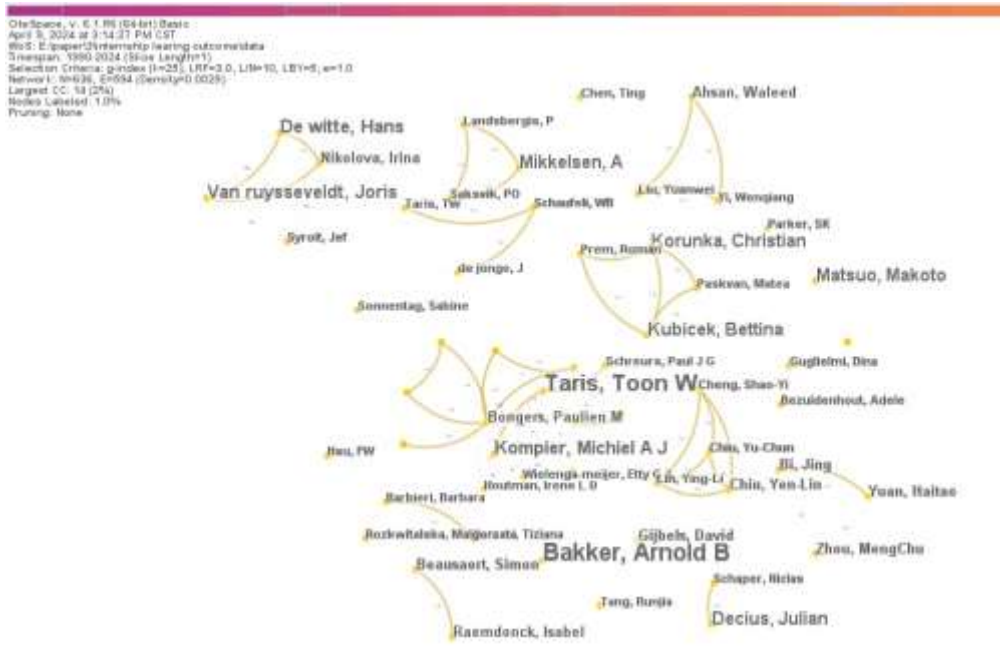


Figure 3 Author collaboration network of job characteristics and learning

Note(s): Nodes=636; Links=594; Threshold=2. The size of the labels shows the number of articles the author published, and the larger the font, the more publications. The thickness of the link line between the labels indicates how closely the authors are connected.

3.3 Visualization of the Institutions

There are 466 institutes involved in research on the topic, with Radboud Univ Nijmegen, Erasmus University, and Katholieke University Leuven starting research in the field as early as 2007 and being very productive, it is worth noting that the latecomer Maastricht University only published its first article in the field in 2019, but in just 4 years became the second most published institution and is one of the institutions currently focusing on this area of research. A look at its publication history via CiteSpace reveals that the institution is relatively active in research with 6 publications in 2022 (Table 2).

From Figure 4, it can be seen that research institutions have formed collaborative groups with Radboud University Nijmegen, Maastricht University, Open University Netherlands, Erasmus University, Katholieke University Leuven, and Univ Utrecht as their core, they had close connections inside these groups. In China, Asia, a research group centered around North West University has formed. In addition to these groups, small collaborative groups represented by Chinese Univ Hong Kong also appear on the right side of Figure 4.

Table 2 Top 16 Institutes

Frequency	Year	Institute	Frequency	Year	Institute
14	2007	Radboud Univ Nijmegen	6	2005	Tilburg Univ
13	2019	Maastricht Univ	6	1998	Chinese Univ Hong Kong
13	2011	Open Univ Netherlands	6	2011	Beijing Normal Univ
12	2007	Erasmus Univ	6	2020	Beihang Univ
12	2007	Katholieke Univ Leuven	6	2012	Monash Univ
7	2001	Univ Utrecht	6	2013	Univ Helsinki
6	2014	North West Univ	6	2004	Univ Amsterdam
6	2007	Univ Valencia	6	2021	Zhejiang Univ

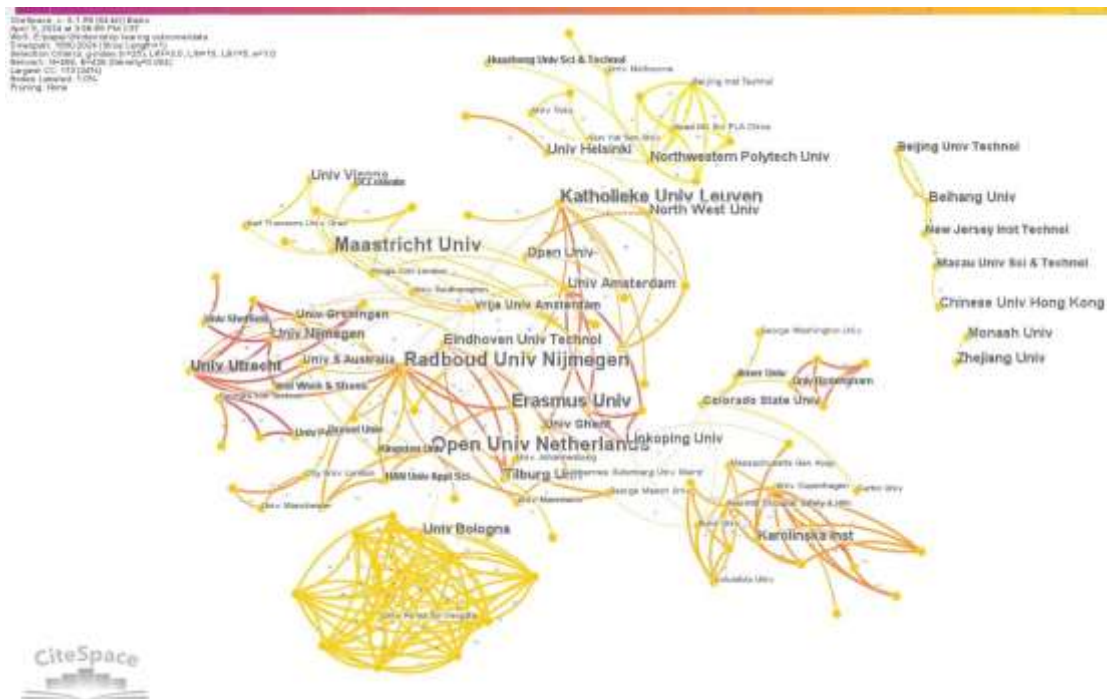


Figure 4 Research institutions' cooperative network of job characteristics and learning research

Note(s): Nodes=466; Links=436; Threshold=2. The size of the labels shows the number of articles the institute published, and the larger the font, the more publications. The thickness of the link line between the labels indicates how closely the institute is connected.

3.4 Visualization of the Countries

From 1990 to 2023, the network of cooperating nations has 79 nodes. The top 28 countries that contributed the most to the total outputs are shown in Table 3. With 201 (23.26%) publications published, the USA is the biggest contributor, followed by China with 121 (14.00%). Research in the United States dates back to 1992, and the United Kingdom (70, 8.10%) was the first country to study learning from this perspective. Earlier than China by 10 years, and looking at the publication history of the two countries, it was found that the US saw a surge in publications starting after 2019, and China published 40 in 2022, showing that workplace learning is fully emphasized in both countries. Netherlands (99, 11.46%), Germany (69, 7.99%),

Australia (63, 7.29%), Canada (43, 4.98%), Norway (20, 2.31%) began to study this topic around 2000, especially the Netherlands, is the countries which is the pioneer country in the development of JD-R theory, explanatory model, and theory development. It has laid the theoretical foundation for research in this field. Five of the top six published countries have universities from this country. Bakker, Arnold B, Taris, Toon W came from this European country. According to the academic cooperation in this field between countries, Figure 5 shows that there is close cooperation between countries, especially in Europe. In addition, the number of publications in the United States and China has grown rapidly in recent years, and cooperation between these countries is also growing. From the perspective of country type, the faster the economic development, the more publications there are.

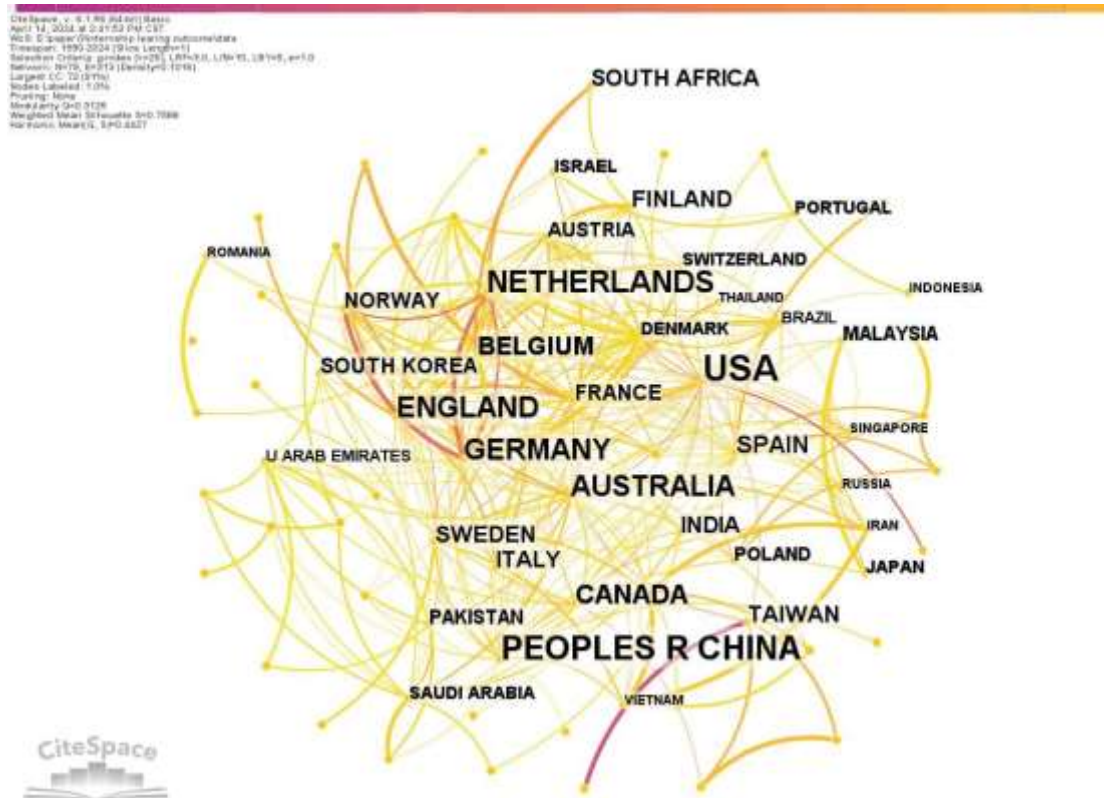


Figure 5 Research countries’ cooperative network of job characteristics and learning research

Note(s): Note(s): Nodes=79; Links=313; Threshold=5. The size of the labels shows the number of articles the country published, and the larger the font, the more publications. The thickness of the link line between the labels indicates how closely the country is connected.

Table 3 Top 28 Countries

Frequency	Year	Country	Frequency	Year	Country
201	1992	USA	23	2009	SOUTH AFRICA
121	2006	CHINA	22	2014	SOUTH KOREA
99	2000	NETHERLANDS	20	1999	NORWAY
70	1992	ENGLAND	19	2010	FRANCE
69	2001	GERMANY	16	2013	AUSTRIA
63	1999	AUSTRALIA	15	2015	MALAYSIA
43	1998	CANADA	15	2018	PAKISTAN
39	2007	BELGIUM	13	2012	POLAND
31	2007	SPAIN	12	2010	JAPAN
29	1991	SWEDEN	12	2010	SWITZERLAND
26	1996	FINLAND	11	2012	ISRAEL
26	1998	TAIWAN	11	2002	DENMARK
25	2013	ITALY	10	2019	PORTUGAL
25	2008	INDIA	10	2018	SAUDI ARABIA

4. Hotspot of Research on Job Characteristics and Learning

4.1 Keyword Analysis

Keywords are a high degree of generalization of academic papers, and paying attention to keywords is conducive to accurately grasping the research hotspots in the subject area. Frequency refers to the number of occurrences of keywords in the literature, and the larger frequency value indicates that there are more relevant research results. This study counts keywords with a frequency of occurrence greater than 20 from 1990 to 2015 and 2016-2023. The results are shown (Table 4) with the hotspots: "job demand", "performance", "work", "strain", "model", "behavior", "stress", "burnout", "health" and "satisfaction" between 1990 and 2015. From 2016 to 2023, the words accrued most frequently are "job demand", "performance", "model", "resource", "work engagement", "burnout", "satisfaction", "work", "behavior" and "motivation". Therefore, it can be seen that research on learning is dominated by antecedent and mediating variables, with "performance", "stress", "burnout", "work engagement", and "satisfaction" as outcomes. Furthermore, a topic's prominence in the keyword co-occurrence network increases with its keyword centrality. In terms of keyword centrality, "job demand" (0.22) has the highest centrality between 1990 and 2015, followed by "work" (0.14) and "behavior" (0.15). The most common term from 2016 to 2023 is "model" (0.18). Additionally, 16 keywords (i.e., job characteristics, impact, self-efficacy, demand; job demand, performance, model, behavior; stress, burnout, satisfaction, motivation; job resource; and work engagement) appear in both phases. This suggests that not many new topics were added to the top 20 popular research topics between 2009 and 2023.

Table 4 Keywords of the research on job design and learning (TOP 31)

1990-2015				2016-2023			
Fre	Cen	Year	Keywords	Fre	Cen	Year	Keywords
43	0.22	1990	job demand	141	0.05	2016	job demand
39	0.11	1992	performance	108	0.06	2016	performance
32	0.14	1994	work	83	0.18	2016	model
29	0.14	1998	strain	80	0.03	2016	resource
24	0.1	1999	model	77	0.06	2016	work engagement
23	0.15	1999	behavior	75	0.06	2016	burnout
22	0.11	2005	stress	58	0.06	2016	satisfaction
19	0.04	2008	burnout	57	0.06	2016	work
19	0.13	1996	health	51	0.02	2017	behavior
18	0.08	1996	satisfaction	50	0.05	2016	motivation
15	0.02	2011	work engagement	50	0.06	2016	stress
15	0.11	1991	job characteristics	48	0.04	2017	engagement
15	0.03	2011	resource	45	0.02	2017	impact
14	0.04	2002	demand	43	0.01	2017	job resource
14	0.08	1999	impact	37	0	2019	machine learning
13	0.05	2001	motivation	35	0.03	2016	antecedent
12	0.01	2008	job resource	35	0.03	2016	self-efficacy
11	0.03	2002	social support	34	0.03	2017	demand
9	0.04	1999	mental health	33	0.06	2016	mediating role
9	0.03	2004	self-efficacy	33	0.06	2016	job characteristics

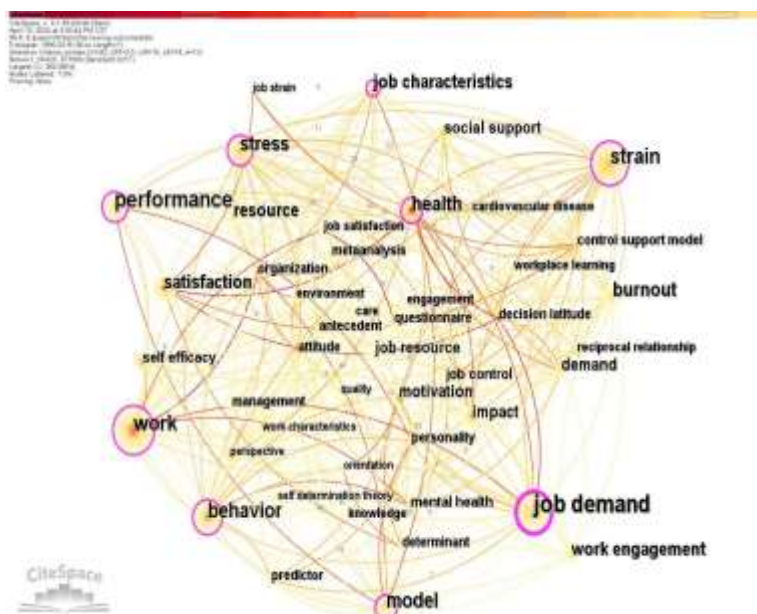


Figure 6 Keywords co-occurrence network from 2009 to 2015

Note(s): The width of the line linking two nodes indicates how many times the two respective keywords are used in a popular article, while the size of the node indicates how many times the corresponding keyword is used in the papers. Keyword frequency: at least 8

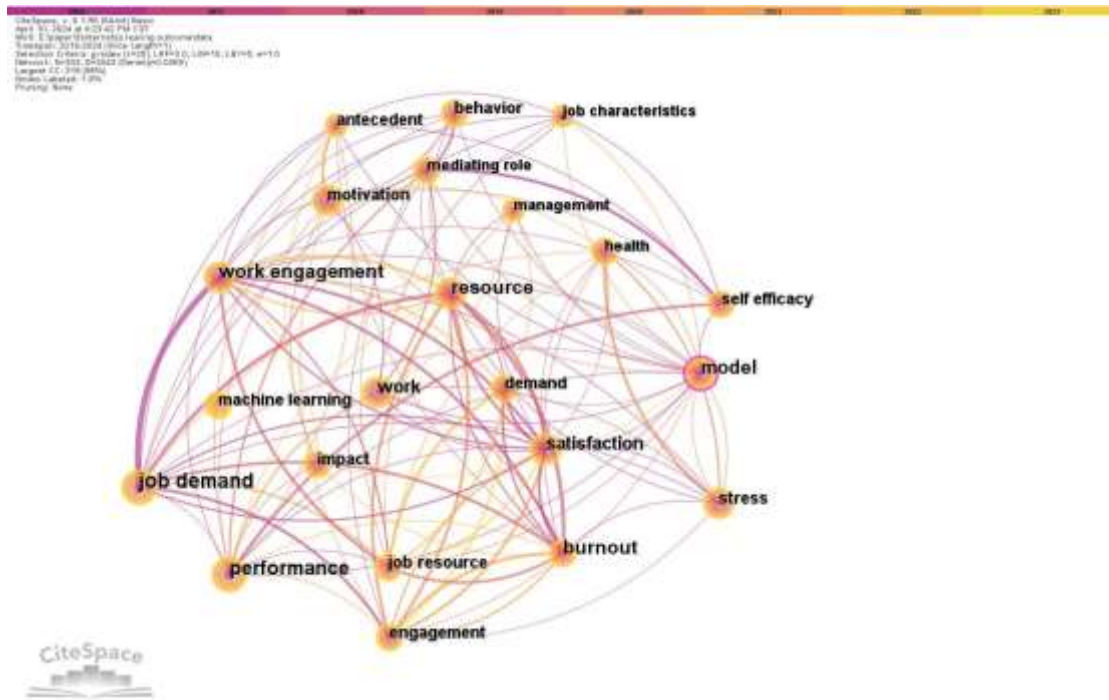


Figure 7 Keywords co-occurrence network from 2016 to 2023

Note(s): The width of the line linking two nodes indicates how many times the two respective keywords are used in a popular article, while the size of the node indicates how many times the corresponding keyword is used in the papers. The frequency of keywords: at least 31

Figure 6 and Figure 7 show the tightness between two keywords, first of all, the larger the circle, the more frequently the keyword appears, and the thicker the line between the two words, the closer they are. As can be seen from the figure, from 1990 and 2015, “job demand”, “work”, “health”, and “decision latitude” appeared most frequently at the same time. The “model” appears most frequently at the same time as “performance”, “health” and “personality”. “Job characteristics” have a high probability of appearing in the same article as “organization” and “health”. Between 2016 and 2023, “job demand” is more closely related to keywords such as “work engagement”, “resource”, “burnout” and “engagement”. The frequency of cooccurrence between “self-efficacy”, “mediating role” and “performance” is high. There is a high probability that “work engagement” will occur at the same time as “Job demand”, “Job resource”, “burnout” and “demand”.

4.2 Keywords Cluster

The LSIs were selected for clustering of keywords and 13 significant clustering modules were obtained with a module value Q of 0.3899 (Q>0.3) and an average profile value S of 0.7265 (S>0.7), suggesting that the clustering was convincing. Figure 8 displays the cluster analysis's final findings. The top 10 clustering modules are 0# work engagement、1# mental health、2# informal learning、3# workplace learning、4# JDR-theory5# job autonomy、6# deep learning、7# intensified job demand、8# cognitive aging、#9 task analysis 。 Through keyword clustering analysis, the research trend of job characteristics and learning can be intuitively reflected. From Table 5, it can be seen that the higher the serial number, the higher the frequency of keyword occurrence in the clustering label, and the more topic words it contains. For example, the 0 # keyword appears 90 times, with 10 topic words; From a timely perspective, before 2010, mental health, workplace learning, information learning, task analysis, and cognitive aging were hot topics at the time. After 2010, work engagement focused on studying the JD-R theory of specific job characteristic dimensions, such as job autonomy, job demand, and deep learning related to digital factors are hotspots.

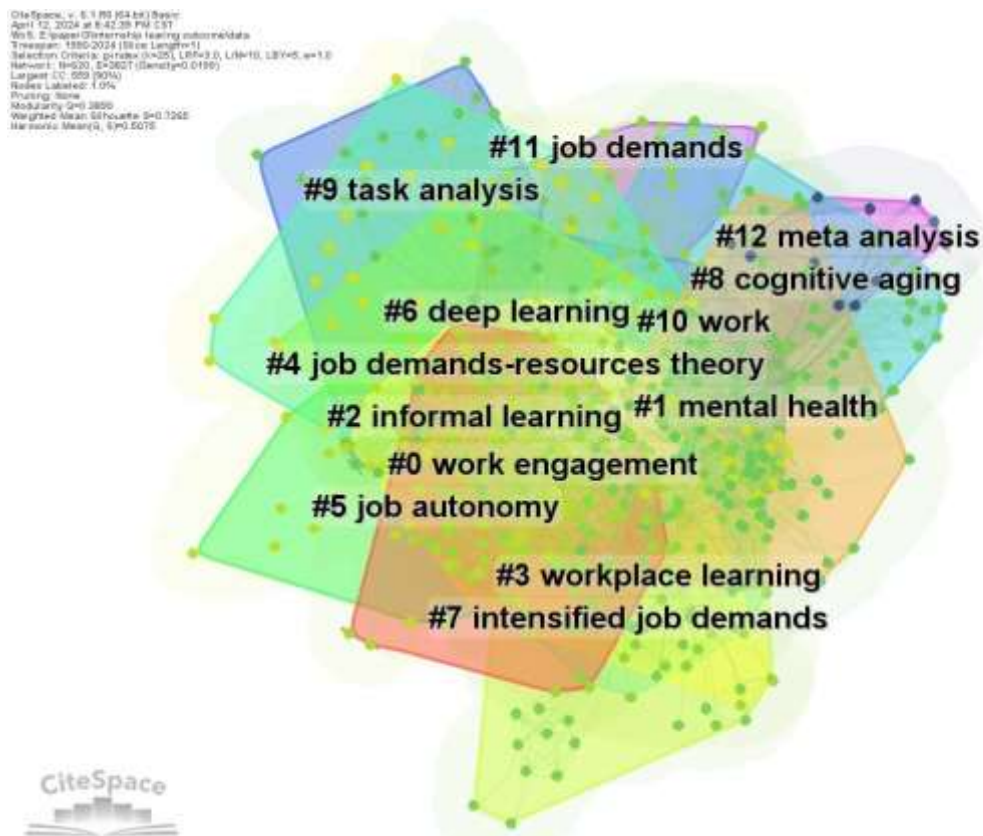


Figure 8 Keywords cluster of job characteristics and learning

Table 5 Clusters and keywords

Cluster	Cluster name	Size	Year	Top Keywords
#0	work engagement	90	2013	work engagement; goal orientation; selfdetermination theory; autonomous motivation; prosocial behavior ; job resources; job demands; personal resources; technological acceleration; structural work factors
#1	mental health	82	2008	job demands; job control; social support; lifelong learning; job demands dimensions mental health; emotional exhaustion; trainee teachers; gross anatomy; regression analysis
#2	informal learning	56	2010	work engagement; error orientation; selfmanaging organization; risking errors; decision autonomy ; learning goal orientation; proactive personality; job autonomy; empowering environment; situational factors
#3	workplace learning	45	2006	workplace learning; job characteristics; organized education; informal learning; formal learning ; job demands-resources model; control-support model; structural equation modelling; employee wellbeing; performance-approach orientation
#4	JDR- theory	43	2015	work engagement; error orientation; selfmanaging organization; decision autonomy; error strain ; job demands-resources theory; career progression index; civil service; job resources; job demands
#5	job autonomy	41	2014	job autonomy; organizational culture; worklife balance; remote work; new starters ; absorptive capacity; management; selfdetermination; work; employee attitude
#6	deep learning	38	2016	machine learning; cloud computing; performance prediction; job characteristics; high-performance computing deep learning; attention mechanism; channel selection; epileptic seizure prediction; time series analysis
#7	intensified job demand	36	2012	job demands; work intensification; organizational change; active learning behavior; demands-related negative affectivity patient connectivity; mixed methods; inflammatory bowel disease; digital intervention; human-media interaction
#8	cognitive aging	36	2005	cognitive aging; job complexity; lifespan development; gray matter volume; healthy aging; job strain; stress; inequality; environment; white hall ii

#9	task analysis	30	2002	knowledge management; knowledge work; organizational climate; organizational learning; knowledge creation product development; memory management; complexity theory; project management; aging workers
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5. The Development Trends and Frontiers of Job Characteristics and Learning

5.1 Keywords Citation Bursts

The coefficient of keyword citation bursts refers to the sudden increase or decrease in the frequency of a keyword during a certain period. The higher the value, the higher the rate of change of the keyword during that period. The citation bursts coefficient reflects the research hotspots and trends in this field during a certain period and can provide directional references for subsequent research. In this study, CiteSpace software was used to summarize and analyze the burst keywords in different periods, and the keyword emergence coefficient map was drawn. As can be seen from Figure 9, the burst keyword in 1996 was "decision latitude", the burst coefficient was 4.43, and the hotspot lasted for 15 years. In 2001, the burst keyword was "control support model", the burst coefficient was 4.69, and the hotspot lasted for 10 years. In 1998, the burst keyword was "strain", the burst coefficient was 11.17, and the hotspot lasted for 15 years. In 2002, the keyword of the burst was "social support", the burst coefficient was 4.49, and the hotspot lasted for 5 years. In 1996, the keyword of the burst was "health", and the hotspot lasted for one year. In 2004, the burst keyword was "goal orientation", the burst coefficient was 3.79, and the hotspot lasted for 2 years. In 2008, there was a sudden change in the keyword "machine learning", and it became popular from 2021 to 2024, which is the new popularity of job characteristics and learning.

Top 7 Keywords with the Strongest Citation Bursts



Figure 9 Top 7 Keywords with the Strongest Citation Burst

5.2 Time Zone View of Job Characteristics and Learning

To gain a deeper understanding of the hot topics and directions in digital literacy research, Citespace software was used to generate Job characteristics and learning keywords time zone maps (see Figure 10). It was found that keywords carry the most important and core information of the literature, and are a highly summarized summary of the literature topic. In the time zone chart, each period corresponds to all newly appearing keywords within that period. If these keywords appear together with previous keywords in the same article, they will be linked by lines. Therefore, it is necessary to conduct keyword co-occurrence analysis on the data to understand which keywords are relatively more frequent during a specific period, and what scientific issues are being discussed with interrelated keywords, which can then determine the evolution of research hotspots. The larger the circle in the figure, the higher the frequency of the word. It can be seen that Job demand has appeared since the 1990s and is the most frequently used keyword. Performance, as a result, variable in the field of learning research, is the longest and earliest studied object. From then on until 2010, research on burnout, strain, stress, and mental health became a hot topic. In addition to Job characteristics, Job resources, and social support also introduced learning research. After 1999, personal behavior, motivation, personality, and goal orientation were also introduced into the field of learning. Several commonly used models have been formed in job characteristics research, such as the Job-control-support model in 2001 and the Job demand-resource model in 2012. In addition, the subdimensions within the two models, such as job control, cognitive demand, social support, job resource, job autonomy, transformational leadership, etc., make the job characteristics research and learning more in-depth and refined. The red origin is the burst words, and the year in which the burst occurred is marked.

Table 6 Term Cluster and Top Term

Cluster	size	Year	Top terms
#0	90	2013	mediating role; work engagement; moderating role; goal orientation; adaptive performance creative customer behavior; task complexity; work stressor; innovative performance; innovative work behavior
#1	82	2008	active learning; work characteristics; occupational health; psychosocial working condition; job resource demand-control model; job characteristics; mental health; task characteristics; nursing student
#2	56	2010	work engagement; work design; informal learning; moderating effect; innovative behavior learning goal orientation; qualitative study; multiple job; learning orientation; d project
#3	45	2006	job resource; job characteristics; moderating role; workplace learning; production industry workplace learning opportunities; curvilinear manner; boosting effect; informal learning; mindful work
#4	43	2015	covid-19 pandemic; compassion fatigue; teacher well-being; teaching selfefficacy; new product development performance mediating role; teacher selfefficacy; hrm practice; informal workplace learning; mediating effect
#5	41	2014	job autonomy; business school; learning motivation; absorptive capacity; business organization job demand; innovative behavior; creating teacher leadership role; workplace learning; graduate nurses
#6	38	2016	hybrid knowledge-assisted; 7-type high-entropy oxide; data-driven machine learning; ultralow thermal conductive; classifying individual website green energy; forecast-based bi-objective scheduling; considering causal inference; deep learning; large-scale point cloud segmentation
#8	36	2005	psychobiological mechanism; socioeconomic difference; psychosocial work characteristics; mental health; construction worker cardiac death; low control work; examining gender differential; cognitive performance; first-year resident
#7	36	2012	evaluation study; digital training intervention; emotional intelligence; weekly diary study; reflective work behaviour national study; mediation model; dutch resident; medical specialty; diary study
#9	30	2002	manual assembly; cognitive perspective; effective knowledge management; knowledge-centered culture; organizational commitment organizational intervention; k-12 teacher; occupational stress; moderating effect; transactive memory system
#11	25	2001	job demand; innovative work behaviour; job-related resources act; registered sickness absence spell; objective job demand operational task; evolving skill; transitional workload; active learning; work-induced change
#10	25	2009	multilevel analysis; job characteristics; job demand; employee engagement; management tool career development; changing business environment; informal learning; developing trainer; professional challenge
#12	12	1998	job perception job satisfaction relationship; test; longitudinal study; alternative specification; supervisor behavior role; skill development; facilitating opportunities; utilization; supervisor behavior

6. The Research Themes of Job Characteristics and Learning

When CiteSpace draws a graph, the number of keywords displayed should not be too large, otherwise the graph will be messy. In addition, the latest keywords cannot be displayed in the graph due to their relatively low frequency, making it impossible for us to mine the latest frontiers. Therefore, to make up for this shortcoming, the author uses HistCite™ software to screen out highly cited articles. There are 41 highly cited articles overall because LCS (local citation score) limits the number of the top-ranked literature to 41. Based on the 41 highly cited articles, the software was used to draw a graph of the relationship between these 41 papers to assist in the classification and summary of the topics in the research field. In addition, 2 nonWOS highly-cited articles were added, and since the first 41 highly-cited articles were mainly published earlier, it was impossible to predict the research trend, so the author added 20 articles with the highest LCS or GCS (global citation score). Concerning the HistCite citation map, and in-depth reading of the above 63 articles, the following five themes are formed. Five key themes are identified (Figure 12) : Theme 1 focuses on the measurement of learning outcomes; Theme 2 centers on learning as antecedent; Theme 3 pertains to learning as a mediator and mediators between job characteristics and learning; Theme 4 focuses on learning as a moderator and the mediators between job characteristics and learning; Theme 5 is the research of learning as an outcome; Theme 6 mainly concerns on the new styles of learning.

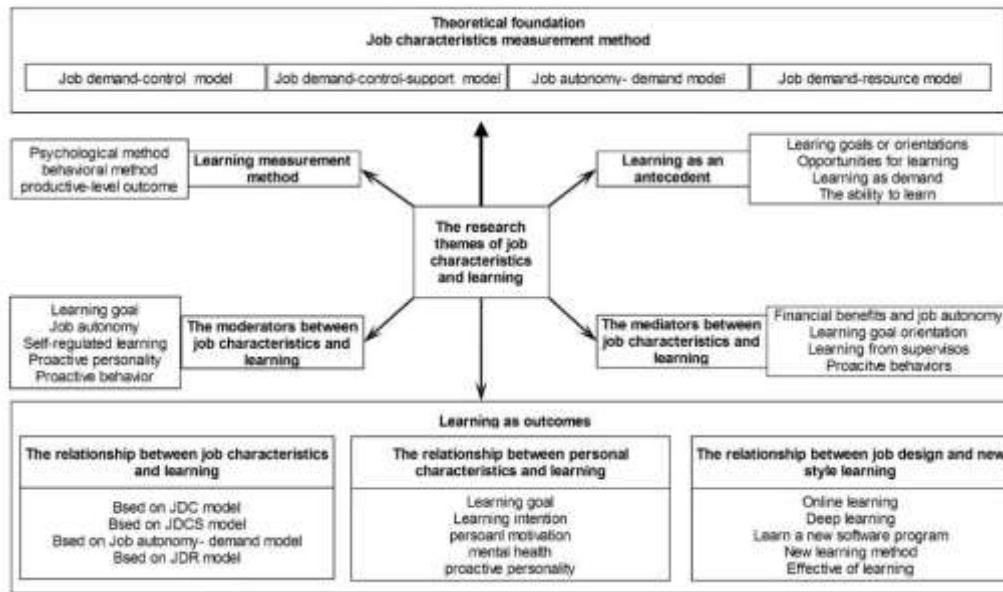


Figure 12 The research themes of job characteristics and learning

6.1 Measurement Methods of Learning

The measurement of learning outcomes is diverse, including psychological, behavioral, or production level outcomes. For example, the measurement of learning-oriented outcomes includes dimensions including perceived mastery, role breadth self-efficacy, and production ownership (Parker & Sprigg, 1999). The degree to which the workplace naturally "invites" employees to acquire new competencies and skills and fully utilize their existing ones could be the topic of a learning metric. (Taris & Kompier, 2005b). Nikolova et al. (2014a, 2014b) showed the workplace's learning earning potential scale and learning climate scale in 2014. Three conceptually significant aspects of the learning climate, facilitation, appreciation, and error avoidance, were identified following a study of the literature on workplace learning and organizational learning. In addition, he identified four conceptually significant aspects of work-based learning that taken together represent the workplace's capacity for learning. The four aspects of learning are learning from peers, learning from supervisors, learning via experimenting, and learning through reflection. In addition to the antecedent variables of learning climate and learning earning potential, there are also measures of informal workplace learning. The behavioral, cognitive, and motivational components of informal workplace learning are incorporated into the measurement process. The octagon mode's eight components are covered by eight things. These eight components are trying/applying own ideas, receiving direct feedback, anticipatory reflection, extrinsic and internal intent to learn, model learning, and various feedback (Decius et al., 2023). These measurement scales can be used for a variety of objectives by researchers, such as empirical studies on the causes and effects of informal workplace learning. (Decius et al., 2023) also present job demand, and job autonomy as antecedents and Knowledge/skill acquisition as informal workplace learning outcomes.

6.2 Learning as an Antecedent

Besides job characteristics, learning goals or learning orientations seem as antecedents that influence workers' learning and competence. The findings of the study on the work-related learning outcomes of parttime vocational education indicate that contrary to expectations and in contrast to full-time employees, job characteristics did not affect work-related learning. Learning orientation has a beneficial impact on learning related to the workplace (Gijbels et al., 2010). Van confirms the result, that learning orientation has a positive effect on learning. In the group of blue-collar, learning goal orientation is seen as a personal trait, and self-directed learning orientation is judged as a work characteristic. Personal characteristics and work characteristics will influence learning outcomes, such as job involvement, newly acquired competency, and organizational citizenship behavior (Decius et al., 2021). Another similar factor, the learning intention is a key for participation in lifelong learning, work-related learning, and continuous training (Kyndt et al., 2011; Kyndt & Baert, 2013). In 2014, Kyndt et al. (2014) found that job characteristics and goal orientation jointly affect workplace learning after conducting quantitative research on the teacher population.

Learning opportunities will increase work engagement (Sarti, 2014). Learning climate, learning culture, or learning value seem as an independent variable that influences a variety of positive behaviors (Eldor & Harpaz, 2016; Budhiraja & Rathi, 2022; Kittel et al., 2021; Van der Heijden & Spurk, 2019).

In some articles, learning is categorized as a demand, predicted burnout, performance, and job satisfaction beyond established job demands (Kubicek et al., 2015; Glaser et al., 2015). Also learning as a demand will influence learning outcomes (Korunka et al., 2015). Mauno et al. (2019; 2020) also specifically studied

learning as a job demand, and in the work environment, learning is both a demand and an output, sometimes coexisting (Prem et al., 2017).

JDR theory can be used to study the relationship between information learning and work engagement. The ability to learn via task-based learning procedures, interactions with coworkers and supervisors, and other opportunities were positively correlated with workers' work engagement levels. Additionally, employees' proactive behavior affected the strength of the correlations between these informal learning techniques and work engagement (Susomrith & Coetzer, 2019).

6.3 The Mediators Between Job Characteristics and Learning

Financial benefits and job autonomy are two organizational features that can encourage an employee's desire to learn. Participating in learning activities might result from having a learning intention. (Kyndt et al., 2011). Learning goal orientation as a mediating variable affects work-learning outcomes (Maden, 2015).

organizational climate, job characteristics, and organizational learning will boost knowledge management or cooperative learning and ultimately influence workers' performance and work satisfaction (Janz & Prasarnphanich, 2003). Also, learning can be used as a mediator between social support and another outcome. (Daniels et al., 2009). However, research shows that not all social support is positive. While the mediating impact of coworkers is not immediately apparent, learning as a behavior and learning from supervisors has a mediating role between social support and training and employee wellbeing (physical health, work engagement, and job satisfaction) (Huo & Boxall, 2022).

In addition to learning itself as a mediating variable, the relationship between job characteristics and workplace learning, and the mediating role of other positive behaviors, such as Job crafting behavior is also becoming a research hotspot (Decius & Schaper et al., 2023). Employees' cognition is impacted by work features such as job complexity, autonomy, relational work design, feedback, and psychosocial pressures through many paths. Various pathways include motivated exploratory learning, rapid knowledge acquisition, and opportunities to employ cognition (Parker et al., 2021). The relationship between positive meaning and both aspects of job thriving was mediated by task focus and exploration. (Niessen et al., 2012). So, knowledge management is an important proactive behavior that mediates the relationship between job characteristics and learning. Feedback is another proactive behavior that plays a mediating role between new ways of working and informal learning styles (Gerards et al., 2020).

6.4 The Moderators Between Job Characteristics and Learning

The moderating effect of learning is reflected in the differences of different individuals in the same work environment. As a kind of goal, learning has a moderating effect on work results. For example, learning goals have a moderating effect on stress and performance (Ma et al., 2021). Zhang et al. (2017) investigated how job autonomy affects creativity and engagement with the moderating role of learning goal orientation and performance pressure. Lin et al. (2018) studied the moderating role of self-regulated learning in job characteristics and attitudes toward web-based continuing learning in the airline's workplace.

In addition, there are many studies on moderating variables between job characteristics and learning.

Proactive personality plays an important moderating role between JDC and learning (Parker & Sprigg, 1999). Other moderators that influence the impact of learning value on job and employability enhancement among employees include leader-member interchange and proactive coping (Van der Heijden & Spurk, 2019). The relationship between proactive vitality management and engagement, learning goal orientation, and performance-avoiding avoid goal orientation are moderating variables (Bakker et al., 2020).

6.5 Learning as an Outcome

Many studies focus on job characteristics or personal factors, or the impact of a combination of the two on workplace learning outcomes.

6.5.1 The Relationship Between Job Characteristics and Learning

Morrison and Brantner (1992) wrote the first article to focus on job characteristics and learning in the literature exported by keyword search in the WOS database, and its influencing factors included time, individual difference, job characteristics, context, and environmental factors, It has laid the foundation for workplace learning research on influencing factors. After this, appearing many articles using the JD-C model (Wall et al., 1996; Parker & Sprigg, 1999; Demerouti et al., 2001; Taris et al., 2003; Taris et al., 2010; Häusser et al., 2014), and job autonomy-demand model (Wang & Netemeyer, 2002) to analyze the learning outcome and learning process. In 2005, (Taris & Kompier, 2005a) proposed the role of social support, deepening the JD-C model, thus forming the later JDCS model (Ouweneel et al., 2009; Gijbels et al., 2010; Vangrieken et al., 2023), JDR model (Bakker et al., 2010). However, not all studies have found that the relationship between job characteristics and learning is valid, and in vocational education, there is no relationship between job characteristics and learning (Gijbels et al., 2010). There is another research finding that the relationship of job demands to such learning was not significant during nursing web-based learning (Chiu et al., 2013).

After the full-dimensional model of job characteristics was formed, and then single-dimensional analysis articles appeared, such as social support (Sarti, 2014), especially feedback, work pressure (Doornbos et al.,

2008), change-related demands (Obschonka et al., 2012), transformational leadership (Song et al., 2012), job resource (Sarti, 2014) that stimulate informal work-related learning.

Gerards et al. (2020) put forward two theories for workplace learning, the JDCS and JDR model. The role of access to organizational knowledge, a specialized resource, and feedback, both of two key elements in improving workplace learning is highlighted. Workplace job demand and job resources are different in different environments. Naidoo-Chetty and du Plessis (2021) found the specific connotation of job demand and job resources related to higher education students through qualitative research, and the detailed research on specific job demand and job resources was deepened.

6.5.2 The Relationship Between Personal Characteristics and Learning

The relationship between personal characteristics and learning is obvious, individual difference variable is a kind of trait competitiveness (Wang & Netemeyer, 2002). The personal factors that are often focused on in the early days are learning goals, learning intention (Kyndt & Baert, 2013), and motivation. Then, beyond motivation, job design is not only concerned with personal motivation but also concerned with physical and mental health, control, and flexibility (Parker, 2014). Another important individual factor that attracts a lot of attention is proactive personality, Parker and Sprigg (1999) thought job demand and job control are only valid for proactive employees when analyzing learning. These findings demonstrate two things: (1) demands and control, as suggested by the dynamic demands-control model, can affect learning; and (2) proactive personality has a significant moderating impact. Teris's research in this area was carried out in 2004, adding personal psychological and behavioral elements to the job characteristics, which is already similar to the JD-R theoretical model (Taris & Feij, 2004).

6.6 The Relationship Between Job Design and New Learning Style

Technological innovation has produced new learning methods, such as online learning, and deep learning. So, in response to new learning methods, new research hotspots have emerged, and many empirical studies have been conducted. The results indicated that job control, psychological flexibility, and the synergistic interaction between the two, predicted people's ability to learn a new computer software program (Bond & Flaxman, 2006). The Digital World has a new impact on job demand and job resources and has become a new research hotspot in the new era (Parker & Grote, 2022). New technologies, as a job resource, will affect learning and will change the way learning and the effectiveness of learning (Ahsan et al., 2021). The JDR model also seems to have explanatory power. Martin et al. (2021) used the perspective of JDR theory to study high school students' online learning and academic performance.

7. Results and Conclusions

Through a systematic literature review, it was found that research on the relationship between Job characteristics and learning has formed a mature analytical model, with JDCS and JDR models being the common explanatory models. This study uses the visual bibliometric literature analysis method, assisting deep reading and summarizing highly cited literature. The combination of the two methods is very beneficial for familiarizing with the research status of Job characteristics and learning, grasping the main authors, institutions, countries, keywords, main topics, timeline evolution, research trends, and research transformations in the field. By carefully reading highly cited articles, we can compensate for the shortcomings of bibliometric literature reviews, such as the neglect of the latest information due to its limited frequency, and the deficiency of insufficient keyword information, which helps us to have a more comprehensive understanding of the research status and trends. It is useful to build a research framework and find new research directions.

7.1 Research Status of Job Characteristics and Learning

7.1.1 Publication Trends. From the perspective of the number of published papers, it can be divided into three stages. From 1990 to 2009, the total number of publications was less than 10. From 2010 to 2015, it was a development period, with a total of 144 papers published over the five years. From 2016 to 2023, it was a period of high publication. 136 papers were published in just 2022. It can be seen that research in this field is gradually increasing, which is related to the benefits of workplace learning for economic development and the urgent need for lifelong learning in the context of rapid economic and social development. Although there were not many papers before 2009, it laid the theoretical foundation for future research in this field. From 2010 to 2015, based on the development of the relationship between Job characteristics and learning, the importance of other personal characteristics was proposed, which formed a theoretical foundation for research in this field. After 2016, research in this field has become more refined, delving into empirical research in various workplaces, age groups, and other value dimensions, thus making research in this field more mature.

7.1.2 Author, Institution, and Country Distribution. We found Bakker and Taris were the leading researchers in this field and have been working in this area since 2000. High-yield authors mainly come from European countries such as the Netherlands. And from institutions of Radboud University Nijmegen,

Maastricht University, Open University Netherlands, Erasmus University, Katholieke University Leuven, and Univ Utrecht. In terms of publication number, the United States and China are the two countries with the highest number of publications, but from the analysis of highly cited literature, influential authors and institutions mainly come from European countries such as the Netherlands. It can be seen that the United States and China are mainly theoretical application countries, conducting empirical research based on the theoretical research foundation of European countries and key authors, attracting a large number of authors, mainly from China and the United States, to participate in this research field. Besides that, from the perspective of cooperation between authors, institutions, and countries, there is a wide range of cooperation and research groups have been formed.

7.2 Research Hotspots of Job Characteristics and Learning

7.2.1 Research Keywords. The article divides all literature into two time periods: 1990-2015 and 2016-2023. Through keyword analysis, it is found that high-frequency keywords do not change much in these two stages, with 16 out of 20 repeated occurrences. Therefore, it can be seen that 16 keywords are the main research content. From 1990 to 2015, “Strain”, “health”, “social support”, and “mental health” were high-frequency words, indicating that during this period, attention was paid to work issues such as workplace stress, health, and mental health. Social support began to be seen as an important job characteristic. From 2016 to 2023, “machine learning”, “antecedent”, and “mediating role” were newly added high-frequency words. It can be seen that this stage focuses on a new form of learning and fully explores the antecedent and mediating variables of learning, supplementing the theoretical achievements of the first stage.

7.2.2 Research Contents. Through keywords cluster analysis, we can see that there are 13 research clusters. The most important research content are 0# work engagement, 1# mental health, 2# informal learning, 3# workplace learning, 4# JDR- theory, 5# job autonomy, 6# deep learning, 7# intensified job demand, 8# cognitive aging, #9 task analysis. The research on the relationship between job characteristics and learning mainly focuses on informal learning, workplace learning, and deep learning. The main theory adopted is the JDR theory. The impact of job autonomy on learning is also an important research content.

7.3 The Development Trends and Frontiers of Job Characteristics and Learning

In recent years, there have been three tendencies in this research field. Firstly, there is a tendency to refine the connotation of explanatory models, such as specific job demands, job resources, and job controls, or to test the explanatory power of models in different groups and application scenarios. The second tendency is to shift from exploring environmental factors to studying individual differences and agency factors, thus placing greater emphasis on studying the mediating or moderating effects of individual psychological and behavioral factors between job characteristics and learning. The third turning point is the study of the changes in Job characteristics and their impact on new learning styles under new technological innovations, exploring key elements and practical implications of workplace learning in new application scenarios.

7.4 The Theme Evolution of Job Characteristics and Learning

7.4.1 Theoretical Foundations. Many studies of job characteristics and learning have inherited the research ideas and models of workplace performance and job burnout. Therefore, the theoretical models adopted mainly include JD-C model (Wall et al., 1996; Parker & Sprigg, 1999; Demerouti et al., 2001; Taris et al., 2003; Taris et al., 2010; Häusser et al., 2014), job autonomy-demand model (Wang & Netemeyer, 2002), JDCS model (Taris & Kompier, 2005a; Ouweneel et al., 2009; Gijbels et al., 2010; Vangrieken et al., 2023), and JDR model (Bakker et al., 2010). Of course, these theories are not mutually exclusive, but inclusive, and the choice of theory depends on the purpose of the research. Based on the theory above, different dimensions and measurements of Job characteristics have been formed.

7.4.2 The Research Theme of Job Characteristics and Learning. Based on bibliometric analysis, and in-depth reading of 63 highly cited articles, in Chapter 6, the research topics of these articles can be roughly divided into five research themes: First, measurement method research. Second, finding mediator variables. Third, finding moderator variables. Fourth, learning as the outcome, and the behavioral and psychological forms of other learning styles as the antecedent variables. Fifthly, studying the effects of Job characteristics and personality characteristics on learning outcomes. In recent years, there has been an increasing focus on proactive personality, such as the two important proactive behaviors proposed by JD-R theory: proactive coping (Van der Heijden & Spurk, 2019) and job crafting (Decius, Schaper, et al., 2023); It is a relatively new research hotspot in the past five years, which also adapt to the demand for in-depth research on the proactive behavior of JD-R theory and its existing research findings.

8. Implications

8.1 Practical Implications

Based on the literature review above, the following practical implications are provided for educators to enhance learning effectiveness.

8.1.1 Understand learning Job characteristics. From existing research, job characteristics have effects on learning. According to existing theories, job demands, job resources, job autonomy, job support, and job control are possible variables that can affect individual learning outcomes. In the education process, educators need to pay attention to these dimensions to avoid negative impacts and provide learners with better job characteristics, or positively understand their job characteristics, thereby improving learning outcomes of students and themselves.

8.1.2 Motivate learners' proactive personality. From existing research, individual factors are the main factor distinguishing the learning outcomes of different individuals in the same environment. A positive mental state mediates or moderates the relationship between job characteristics and learning. Therefore, educators should stimulate students' or their interest in learning, help them establish clear learning goals and orientations, and maintain a positive and upward mental state. Then help students or themselves achieve good learning outcomes.

8.1.3 Guide learners' proactive behavior. In addition to a positive mental state, proactive behavior mediates or moderates the relationship between job characteristics and learning. Based on the cognition above, cultivating proactive behavior habits will help improve learning outcomes. These proactive behaviors include proactive copying, Job crafting, self-regulation, and so on.

8.2 Implications for Later Researchers

As we can see, the research on this topic has formed a theoretical foundation and there are also rich empirical research cases. But at least two directions are worth further research in the future. Firstly, research on learning in new work environments and learning methods. Through quantitative analysis and in-depth reading, it is found that new forms of learning or new technologies of learning (such as online learning, software learning, AI learning, etc.), or new work environments (such as online work, remote work, crossnational work, etc.) have an impact on learning. Some studies suggest that the JD-R theory also has explanatory power (Martin et al., 2021), but it needs further empirical research to test it. Secondly, from existing perspectives, JD-R or other model theories cannot explain all groups, such as internship groups, elderly groups, etc. Therefore, research on Job characteristics and learning can delve deeper into more specific groups, and there may be more unexpected findings. Thirdly, the sub-dimensions of job characteristics, proactive personality, and proactive behavior still need to be further explored. Such as the effect of different forms of proactive behavior (job crafting, knowledge management, job copying, etc.) on the relationship between job characteristics and learning. Or the dimensions of job characteristics (job demand, job resource, job support, job control, or job autonomy) or sub-dimensions (such as workload, pressure, job autonomy, etc.) that will influence learning. Fourthly, research on the mechanism of the impact of job characteristics on learning, such as identifying important mediators or moderating variables, to identify the accelerators of job characteristics on learning outcomes. Compared to the study of Job characteristics on job performance, and job burnout, there is still a lot of room for exploration in the relationship between Job characteristics and learning.

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