A Bibliometric Analysis of Digital Competency Studies in Rural Areas

Rosita Novi Andari

Research Center of Community Welfare, Village and Connectivity
National Institute of Research and Innovation Agency
Jakarta, Indonesia
rositanovi@gmail.com/rosi014@brin.go.id

Abstract—**Digital competency studies in rural areas have developed rapidly over the past few years, especially since the COVID-19 Pandemic. However, systematic literature reviews in exploring the development of knowledge bases about digital competence in rural areas are still limited. This research aims to overview digital competency studies in rural areas by applying Scopus data-based bibliometric analysis and visual analysis with VOSviewer. The results showed that this Study first appeared in 2011 and reached its peak in 2021. The domain of knowledge is the subject area of social science and the research topics are "e-learning"; "covid-19"; "online learning"; "higher education"; "rural education"; and "rural residents". This research found the development of the knowledge base of digital competency studies in rural areas both conceptually and empirically. This research contributes to developing future conceptual studies (the development concepts and models of digital competence) and empirical focus studies (digital innovation, technology adoption; digital learning; and others), and locus studies in Developing Countries; High Income, Lower Middle Income, and Low-Income Countries in various regions**

Keywords—*rural digital transformation, digital competency, bibliometric analysis, rural areas*

I. INTRODUCTION

The mainstreaming of rural digital transformation is an essential development plan, especially since the Covid-19 Pandemic. The rural digital transformation mainstreaming is carried out, among others, by introducing digital technology in all areas of rural communities' life to increase their quality of life [1]. However, rural digital transformation is experiencing obstacles because there is still a digital gap between people in rural and urban areas such as Europe and Finland [2]; Russia [3]; Kenya [4]; Slovakia [5]; and South Africa [6]. Another major factor is the lack of digital infrastructure. In addition, most rural communities are less digitally literate, competent, and motivated to receive services in digital format due to the high proportion of older people [7], [8] and retirees [9]. Factors of exclusion, shelter, socioeconomic status, gender, and education affect the level of digital competence in rural communities which tend to be lower than in urban communities [10]. The problem shows that digital competence for rural communities is one of the keys to the success of digital transformation in rural areas. The availability of digital competencies for digital transformation is an urgent task for the country [11].

In general, digital competence is related to people's knowledge, skills, and attitudes in using information and communication technology and utilizing it to meet their needs. It is the primary competency for lifelong learning [12], [13]. It is an essential skill for survival and an asset of digital knowledge [14]. Digital competence plays a key role in improving quality of life [15] and achieving success in the field of life [16], social, educational, and occupational [12], and economic rural communities [3], [8].

Previous literature review research suggested the Study of digital competence in rural areas as a field that needs further research to address the effects of digitization on inequality between regions, rural and urban [8]. This Study has been widely conducted theoretically and empirically and involves various disciplinary approaches. However, research that systematically maps the development and change of the research landscape on digital competence in rural areas over time is still limited and essential to do.

Therefore, this study explores changing landscapes and digital competencies in rural areas over time through a systematic literature review with a Bibliometric Analysis. The results of this Study illustrate broadly the development of the base and domain of knowledge and the evolution of digital competence in rural areas over time. The contribution of this research is to help researchers find research boundaries and research gaps in digital competency studies as the basis of future research.

II. LITERATUR REVIEW

The concept of digital competence is often associated with the idea of digital literacy and digital skills. Digital competence is a competency related to literacy and the ability of individuals and society the use information and communication technology [7], [8]. Digital competence refers to learning, working, relaxing, playing, and using ICT confidently and creatively [14]. Van Deursen and Van Dijk have devined digital skills as operational skills (the skills in operating digital media); formal skills (the skills in handling the structures of digital media; information skills (the skills in locating information in digital media); and strategic skills (the skills in employing the information contained in digital media towards personal (and professional) development [17].

Another concept mentions that digital competence has a broader meaning than digital literacy. Digital competence

encompasses more comprehensive socio-cultural knowledge, skills, and attitudes than simply using digital technologies but is also characterized by the need to understand and consider the broader implications and effects of digital technology on individuals and society [18]. Digital competency is a pluralistic concept. This describes a combination of knowledge, skills, and attitudes (communication, creativity, information management, personal development, etc.); domain (daily life, work, privacy & security, legal aspects); and level. There are 12 areas of this digital competence area, namely (1) general knowledge and functional skills; (2) use in everyday life; (3) specialized and advanced competency for work and creative expression; (4) technology-mediated communication and collaboration; (5) information processing and management; (6) privacy and security; (7) legal and ethical aspects; (8) balanced attitude towards technology; (9) understanding and awareness of the ICT role in society; (10) learning about and with digital technologies; (11) informed decisions on appropriate digital technologies; and (12) seamless use demonstrating self-efficacy [19].

The definition of digital competence covers five competency areas, namely (1) information (browsing, searching, filtering, evaluating, storing, and retrieving information); (2) communication (through technologies for interacting, sharing, engaging, collaborating, netiquette, managing digital identity); (3) content creation (developing, integrating and re-elaborating, copyrighting and licensing, and programming); (4) safety (protecting devices, personal data, health, and the environment); and (5) problem-solving (solving technical problems, identifying needs and technologies respond) [13].

III. RESEARCH METHODE

The research method used is the quantitative bibliometric method. This utility method is to decrypt, evaluate, and monitor published research. This method can analyze the performance of individual publications and institutions and map the structure and dynamics of the scientific field more macro to find patterns in research (body of work) and provide a graphical description of the Study [20]. Bibliometric study workflows in this Study include: First, data collection using the Scopus database provides data sets of citation journals that allow researchers to map and describe their specialties systematically [21]. Research topic search strategy by using the phrases "digital competency" or "digital competence" or "digital competencies" and "rural" or "village" with limits on the search type of journal articles and documents conference paper in English or as follows: (TITLE-ABS-KEY ("digital competency") OR TITLE-ABS-KEY ("digital competence") OR TITLE-ABS-KEY ("digital competencies") AND TITLE-ABS-KEY ("rural") OR TITLE-ABS- KEY ("village")) AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "cp ")) AND (LIMIT-TO (LANGUAGE , "English ")). This strategy found 26 documents on May 24, 2022. Second, data analysis includes Scopus analysis and bibliometric analysis with VOSviewer, which provides journal co-citation analysis, co-authorship analysis, author co-citation analysis, and co-occurrence keyword analysis. Third, data visualization using Tableau Public 2022 and VOSviewer.

This study has limitations in the dataset of articles downloaded from Scopus. A single database has limitations; it does not include influential research found in other databases. This research focuses on publications with article document types and proceeding papers in English. In contrast, publications in books, reviews, and different kinds of documents in another language are not part of the analysis process. Another limitation is the content analysis pada closed access paper only on an abstract piece.

IV. RESULT AND DISCUSSION

A.   Publication Trends Analysis

Based on the results of the Scopus analysis, from Figure 1 can be known that from 26 documents, digital competency studies in rural areas were first published in 2011 with the number of articles as many as 1 document. After that, in 2013-2015 there was no publication of research articles on this Study. The digital competency study was republished in 2016 with as many as 2 documents and then experienced rapid growth in 2020 with seven documents and reached their peak in 2021 with the number of articles as many as 9 documents. The publication of articles in 2020 became the publication with the most citations, namely 58 citations.
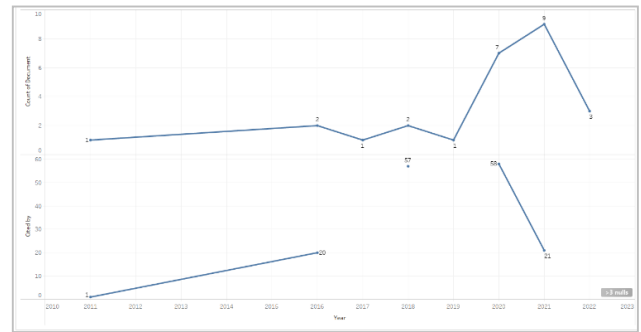

Fig. 1.   Publication Trends of Digital Competency Studies in Rural Areas

Source: Processed data from Scopus (May 24, 2022)

B.   Analysis of Co-Citation Sources
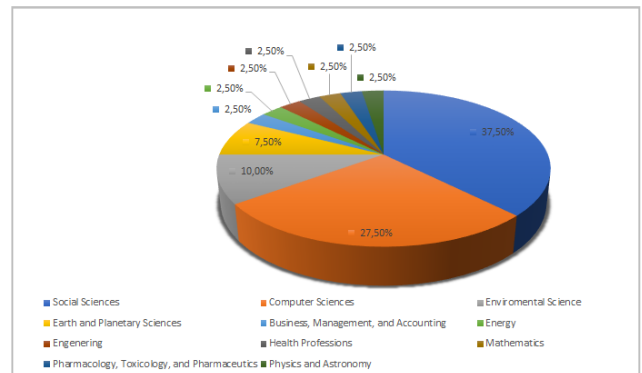

Fig. 2. Digital Competency Studies in Rural Areas   According to Subject Study

Source: Processed data from Scopus (May 24, 2022)

The Study of digital competence in rural areas amounting to 26 documents came from 16 journal articles (61.5%) and 10 conference papers (38.5%). The results of the Scopus analysis as seen in Figure 2 show that Social Sciences dominate the subject area in the Study of digital competence in rural areas by 37.50%; Computer Sciences by 27.50% and Environmental Science by 10%.

Furthermore, the analysis of co-citation sources on VOS viewer (Fig 3) founds 28 sources connected from 711 sources with a minimum number of source citations of 3. Closely, 131 links, a full-strength link of 1360, and 3 clusters in different colors. Each cluster represents a group of journal and conference paper sources that share a similar orientation on the Study of digital competence in rural areas.
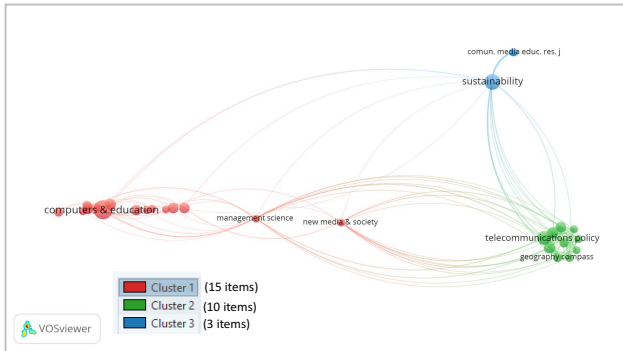

Fig. 3.   Co-Citation Sources Network

Source: Processed data from VOSviewer (May 17, 2022)

TABLE I.   THE 10 MOST INFLUENTIAL JOURNALS OF DIGITAL COMPETENCY STUDIES IN RURAL AREAS

No	Source	Subject Area	Affiliation	SJR 2021	Citation	Total Link Strength
1.	Telecommunications Policy	Business, Management and Accounting; Computer Science Economics; Econometrics and Finance; Engineering; Environmental Science; Social Sciences	Universities and Research Institute in United Kingdom	Q1	9	360
2.	Journal of Rural Studies	Agricultural and Biological Sciences Social Sciences (Development; Geography, Planning and Development; Sociology and Political Science)	Universities and Research Institutions in United Kingdom	Q1	6	258
3.	Regional Studies	Environmental Science, Social Sciences	Universities and Research Institutions in United Kingdom	Q1	6	258
4.	Research Policy	Business, Management and Accounting, Decision Sciences, Management Science and Operations	Universities and Research Institutions in Netherlands	Q1	5	220
5.	Geography Compass	Earth and Planetary Sciences, Environmental Science, Social Sciences	Universities and Research Institutions in United Kingdom	Q1	4	180
6.	Information Economics and Policy	Economics, Econometrics and Finance, Environmental Science	Universities and Research Institutions in Netherlands	Q1	4	180
7.	Computers and Education	Computer Science, Social Sciences (Education, E-learning)	Universities and Research Institutions in United Kingdom	Q1	17	170
8.	Sustainability	Energy, Enviromental Sciences, Social Sciences (Geography, Planning and Development)	Universities and Research Institutions in Switzerland	Q1	11	141
9.	Geoforum	Sociology and Political Science	Universities and Research Institutions in United Kingdom	Q1	3	138
10.	Growth and Changes	Environmental Science (Global and Planetary Change)	Universities and Research Institutions in United Kingdom	Q1	3	138

Source: Processed data from VOSviewer and SCImago Journal Rankings (SJR) (May 24, 2022)

The dominant subject area of this Study is social science which focuses on education, geography, planning, and development; sociology and political sciences; business, management, and accounting; and economics. Journal

Telecommunication Policy at Universities and Research Institutions in the United Kingdom became the most influential Q1 journal on digital competence in rural areas with 9 citations and 360 total link strength.

C.   Author Co-Authorship and Co-Citatin Analysis

There are 72 authors in this Study. Analysis of the author's co-authorship can help evaluate the author's scientific performance in collaborating with other authors. Analysis of the author's co-authorship found 34 authors connected from 72 authors with a minimum number of source citations 1. Figure 4 shows that there is a cluster connects six collaborating authors who collaborated on writing an article entitled "Transformation of Education Processes and Preparation of Competencies for the Digital Economy" [22] with 1 citation and five-link strength of 5.
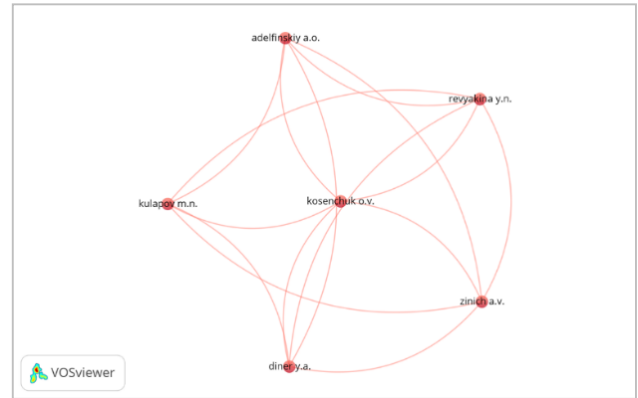

Fig. 4.   Author Co-Authorship Network

Source: Processed data from VOSviewer (May 24, 2022)

The author's co-citation analysis can help to evaluate the author's scientific performance and the intellectual structure of digital competency studies. Authors who have the highest number of co-citations and degrees of centrality can be identified as major contributors in this area of research. The results of the VOSviewer analysis found a co-citation analysis of 1669 authors with a minimum number of citations of an author as many as 3, found 45 authors who were closely connected with 256 links and 1472 link strength 1472. Figure 5 shows six clusters each such cluster represents a group of authors in this Study that have conceptual or empirical similarities located close to each other.
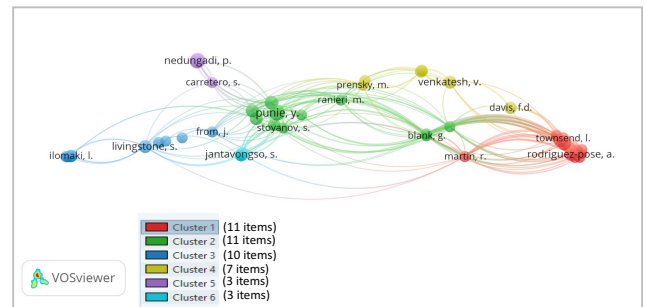

Fig. 5.   Author Co-Citation Network

Source: Processed data from V. os Viewer (May 24, 2022)

Figure 5 shows 9 authors on Cluster 1 such as Rodriguez Pose, A; Malecki, E.J; Frey, C.B; Sternberg, R; Townsend, L.C; Wallace, C; Briglauer, W; Withacre, B. E; Wright, M. T; included in the ten most influential authors in this Study as Table 2. As for Rodriguez Pose, A is the main contributor of this Study with six citations and 204 link strength. While the author in Cluster 2, Punie, Y became one of the ten most influential authors in this Study. No one author in Clusters 3, 4, 5, and 6 included in the ten authors was most influential on this Study. Meanwhile, when viewed from its affiliation, authors from institutions in Europe and United States or writers from Developed Countries dominated the Study of digital competence in rural areas.

TABLE II. THE 10 MOST INFLUENTIAL AUTHORS ON DIGITAL COMPETENCY STUDIES IN RURAL AREA

No	Author	Affiliation	Citation	Total Link Strength
1.	Rodriguez-Pose, Andrés	London School of Economics and Political Science, London, United Kingdom	6	204
2.	Malecki, Edward J	University of Florida, Gainesville, United States	5	154
3.	Frey, Carl Benedikt	Oxford Social Sciences Division, Oxford, United Kingdom	4	144
4.	Punie, Y	European Commission Joint Research Centre	9	144
5.	Sternberg, Rolf G.	Gottfried Wilhelm Leibniz Universität Hannover, Hannover, Germany	4	144
6.	Townsend, Leanne C.	The James Hutton Institute, Aberdeen, United Kingdom	4	121
7.	Wallace, Claire Denise	Lancaster University, Lancaster, United Kingdom	4	121
8.	Briglauer, Wolfgang	Universität Passau, Passau, Germany	3	111
9.	Whitcare, Brian E.	University of Maryland, College Park, College Park, United States	3	111
10.	Wright, Mike T.	Imperial College Business School, London, United Kingdom	3	111

Source: Processed data from Scopus and VOSviewer (May 24, 2022)

D. Co-Occurance Keyword Analysis

Co-Occurrence keyword analysis examines the frequency with which keywords appear that indicate the domain of knowledge from this Study. VOSviewer analysis found 195 keywords. Furthermore, with a minimum number of keywords amounting to 2 of the 455 keywords found, the results of 28 keywords were categorized into 5 clusters with 120 links and a total links strength of 153 as shown in Figure 6.
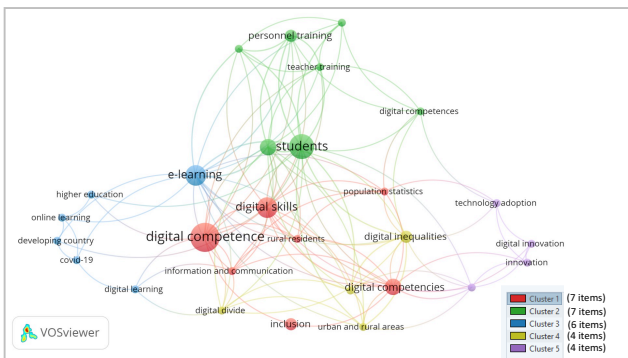

Fig. 6. Keyword Co-Occurrence Network

Source: Processed data from VOSviewer (May 23, 2022)

TABLE III. TOP 10 MOST INFLUENTIAL KEYWORDS IN DIGITAL COMPETENCY STUDIES IN RURAL AREAS

No	Keyword	Citation	Total Link Strength
1.	students	6	32
2.	E-learning	5	29
3.	Rural areas	4	25
4.	Digital skill	7	22
5.	Digital competence	3	18
6.	Personal training	4	17
7.	Digital competencies	3	16
8.	Digital Inqualities	2	15
9.	Rural education	2	13
10.	Educational institutions	2	12

Source: Processed data from Scopus and VOSviewer (May 24, 2022)

Figure 6 shows the keyword "digital competence" in Cluster 1 as the most significant occurrence with seven links and eight link strengths. The keyword "digital competencies" has four occurrences and a total link strength of 16. In Cluster 1, the keywords "digital skills" and "digital competencies" are included in the ten most influential keywords in this Study. While the keyword "digital competencies" is found in Cluster 2 with occurrences of as many as two and seven total strengths. In this cluster, the keyword of "students" became the most influential keyword in the digital competency study area in rural areas, with six citations and 32 link strengths shown in Table 3.

Furthermore, the keyword of "e-learning" in Cluster 3 is one of the ten most influential keywords in this Study. Meanwhile, the keywords "digital inequalities" and "educational institutions" in Cluster 4 are included in the ten most influential keywords in this Study. While there are no keywords in Cluster 5 included in the ten keywords that are most influential in this Study. Overall, the most influential keywords that gained more attention from researchers worldwide in this Study can be seen in Table 3.
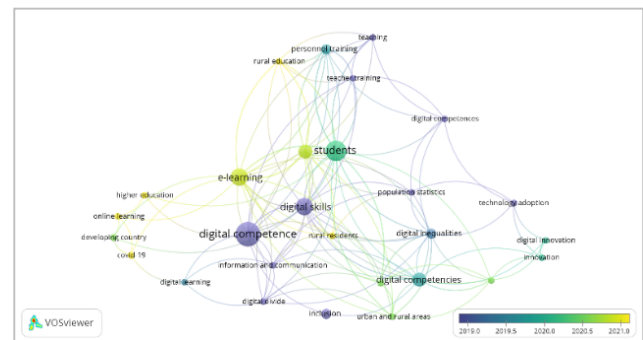

Fig. 7. Overlay Visualization Network Co-Accurance Keyword

Source: Processed data from VOSviewer (May 24, 2022)

Overlay Visualization in Figure 7 shows the keyword network of this Study at a certain period. Digital competence in rural areas began to get a lot of attention from researchers in 2019. That year, keywords such as digital competencies;

"digital competence"; "digital skills; "digital competences"; "digital divide; "populations statistics"; "inclusion"; "technology adoption"; and "teacher training" were the main concern of the researchers. Then, this Study reached its peak in 2021 with the keywords "e-learning"; "covid-19"; "online learning"; "higher education"; "rural education"; and "rural residents" as the focus of the researcher's attention. In addition, this Study in 2020 also found a key that represents the geographical area, namely "developing country" and connects to the keyword "covid 19"; e-learning; "online learning"; and "digital skills"

The results of the Scopus and VOSviewer analysis show that the knowledge base for this Study first appeared in 2011, namely Koyuncu, M's article entitled "Impact of Digital Competence on Student Academic Achievement" [12]. The article "Towards an Inclusive Digital Literacy Framework for Digital India" [23] became the most influential article in the Study of digital competence in rural areas with 52 citations. Furthermore, this Study reached its peak in 2021. Article "Digital Competencies Among Student Populations in Kosovo: The Impact Of Inclusion, Socioeconomic Status, Ethnicity and Type of Residence" [24] became the most influential article with 16 citations.

The results of further analysis of the contents of 26 documents found the development of the knowledge base of the Study of digital competencies in rural areas both conceptually and empirically. Conceptually, the definition of digital competence has evolved from digital literacy [7], [8]; digital skills [14], [17]; to digital competence [13] as outlined in Part Literature Review.

TABLE IV.   LOCUS OF EMPIRICAL STUDIES ON DIGITAL COMPETENCE IN RURAL AREAS

No	Classification Countries		
	Region	WESP	Economies by per capita GNI in June 2019
A	East Asia		
1	China	Developing Coutries	Upper Middle Income
2	Papua New Guinea	Developing Countries	Lower Middle Income
3	Thailand	Developing Countries	Upper Middle Income
B	South Asia		
1	India	Developing Countries	Lower Middle Income
C	European Union		
1	Finlandia	Developed Countries	High Income
2	Ireland	Developed Countries	High Income
3	Slovakia	Developed Countries	NA
4	Spain	Developed Countries	High Income
5	Sweden	Developed Countries	High Income
D	Other Europe		
1	Norway	Developed Countries	High Income
E	Commonwealth of Independent States and Georgiac		
1	Kazakhstan	Economic in transition	Upper Middle Income
2	Russian Federation	Economic in transition	Upper Middle Income
F	East Africa		
	Kenya	Developing Countries	Lower Middle Income
G	Southern Africa		
	South Africa	Developing Coutries	Upper Middle Income
H	Not Avalaible (NA)		
	Kosovo		

Source: Processed data based on the World Economic Situation and Prospects (WESP) [25].

Empirically, several studies of digital competence in rural areas reveal a wide range of problems related to the digital divide between rural and urban areas [2]–[6]; inhibiting factors of digital transformation [10], [24], [26], [27]; and the urgency of digital competence in a rural area [3], [8], [11]–[16], [28] as outlined on Part Introduction. Furthermore, this Study can be seen from the locus of research countries. Table 4 shows the dominant empirical studies of digital competence in rural areas are Developed Countries and Higher Income Countries in Europe as Spain [13]; Slovakia [5]; Finland [2], [9]; Sweden [29]; Ireland [24]; and Norway [16]. In addition, economics in transition countries and upper middle income in the Commonwealth of Independent States and Georgia as Russian Federation [1], [3], [27], [30], [31] and Kazakhstan [31]. While empirical studies of digital competence in rural areas of Asian countries, Africa and other regions are still limited in Kenya [4], [32], [33]; South Africa [6]; India [23]; China [1], [14], [34]; Papua New Guinea [17]; Thailand [15] and Kosovo [10].

V. CONCLUSION AND FUTURE WORK

The results showed that the Study of digital competence in rural areas began in 2011 and reached its peak in 2021. Social sciences are the dominant discipline area subjects in this area with focuses on education; geography; planning, and development; sociology and political sciences, business, management and accounting; and economics. Journal Telecommunication Policy at Universities and Research Institutions in the United Kingdom became the most influential Q1 journal in this study. Rodriguez Pose, A was the most influential major contributor to this Study. The most influential key ka in this study area is "students". Then the keyword "e-learning"; "covid-19"; "online learning"; "higher education"; "rural education"; and "rural residents" became the focus of researchers' attention in 2021. Analysis of the contents of the literature found the development of the knowledge base of this study both conceptually (the concept of digital competence) and empirically (the problem of digital inequality; the inhibiting factors of rural digital transformation and the urgency of digital competence, and the dominance of the research locus).

Future research needs to examine developing digital competency concepts and models more comprehensively, inclusive and contextual. The study of digital competence in rural area needs to focus in art and humanities; agricultural; environmental sciences; and economics. Empirically, the qualitative, quantitative and mixed-method studies on digital competence in rural areas need to focus in current topics such as digital innovation, technology adoption; and other topics. The study also needs to focus in Developing Countries; High Income; Lower Middle Income; and Low-Income Countries in various regions as research locus.

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