Chapter 5 - Technology Enhanced Learning (TEL) Pedagogy for Quality Education: Insights and Prospects

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Chapter Highlights

- The Chapter is comprehensive in nature defining the growth in a publication related to the TEL curriculum and pedagogy for quality education for the past 22 years.
- Global contribution from authors and their research productivity in the domain of Technology Enhanced Learning is explained through different software like Vos Viewer and Biblioshiny.
- The chapter has highlighted studies instrumental in shaping the knowledge base of TEL and quality education since 2000.
- Influential themes that have emerged over the past 22 years are explained through bibliographic coupling.
- In the present era what is the focus area of the different researchers and academicians is presented through the analysis of trending topics in TEL.
- Thematic mapping in four quadrants is presented through the author's keyword analysis.
- The introduction part of the study has explained the essence of the study post-COVID-19 pandemic.
- The discussion part of the study has explained the different dimensions of the TEL and its interlinkage with SDG-4.
- Study has done a quantitative assessment of publication trends, annual growth, author and country productivity, and their collaborative tendency assessment.

Introduction

The recent advances in technology have opened up new avenues in each domain of life. The education sector has also immensely benefited from the use of technology, specifically when the COVID-19 pandemic was around. During the pandemic, all the traditional learning methods have shifted towards virtual learning. The COVID-19 pandemic has moved the focus of the academic fraternity to teach online and played a significant role in reshaping the entire educational model (Van der Spoel et al., 2020). A research study was conducted on 200 Dutch teachers to understand Teaching-Learning expectations during the pandemic. Results demonstrated a significant change in teachers' perception regarding their resolutions to implement technology in their lessons in a post-corona era. The growing expectations of learners witnessed a considerable change (Van der Spoel et al., 2020). Teaching The importance of education cannot be undermined as it facilitates lifelong learning and enhances the quality of life in a country. Technology offers immense opportunities to learn, ensures that teaching happens more productively, and contributes to the overall knowledge creation for the students. Le et al (Le et al., 2019) are of the view that technological advancement has transformed education into more of a personalized experience for learners.

Digitalization of education has led to pedagogical innovation which confirms the quality of education. Teachers use technology primarily for delivering content and developing distance learning sessions. (Liu, 2011). Intention to use a particular technology is guided by the Theory of Reasoned Action Approach. The theory supports the view that intention to use is the most important predictor of the behavioral intention of it in the future. The higher the intent to use technology, the more likely the behavior is likely to happen. Also, if a person perceives a certain behavior positively, he/she is more likely to influence their social contacts and family members to perform that behavior even in the future. digital transformation has happened across all sectors, it is important to adapt and renew one’s skills to meet the changing requirements. In the education sector, digital technologies have a lot to offer to the education sector that will not only ensure an intense engagement for learners but will improve the quality of their learning experience.

The term Technology Enhanced Learning (TEL) is a combination of all the tools, techniques and approaches in which technology supports the teaching learning process especially students augmented learning (Noroozi et al., 2012). Terms like e-learning, web-based

learning, online learning come under the purview of technology enhanced learning (Noroozi and Hatami 2018). Technology is employed in the education sector to enhance the critical thinking skills, active engagement and overall utilizing their potential (Visvizi et al., 2018) Higher educational institutions play a key role in imparting the knowledge required to face the complex challenges faced by the economy. This can be addressed through providing access to quality education to the learners of today.

Quality education is the vision of every country and is one of the SDG given by the United Nations. Quality education is seen as one of the important drivers of sustainable development of a country. When we talk about quality education, it is not possible without a well-designed and practical skill-oriented curriculum that can help the learners to adapt to the changing needs of society. For ensuring effective curriculum, inputs from key stakeholders (alumni, industry experts, academicians) should be sought to make it more meaningful and thereafter a feedback mechanism has to be ensured to review the curriculum each year.

Technology is also one of the enablers of quality education. Learning and technology go hand in hand and synergize with each other quite well. The learning process cannot be separated from technology as it is now considered as integral in our day-to-day requirements. The central figure in the process of education and learning is the teacher who is the decision-maker about the technologies to be employed and pedagogical approaches to be used.(Trepule et al., 2015). Hermans et al (Hermans et al., 2008) are of the view that teachers who believe in adopting a learner-centric approach to teaching-learning have a positive attitude towards technology enhanced learning as compared to those who adopt teacher-centric approach. The role of a teacher is not to just transmit information and knowledge but to ensure learner's engagement in such a manner that leads to high level of cognitive and interpretative skills for the learners.

For Technology Enhanced Learning to be effective, the course design/curriculum and the learning environment must promote active forms of learning, decision-making, problem-solving and interpretation skills(Roth & Roychoudhury, 1993). The research revolves around higher education institutions as they produce competent leaders of tomorrow. As technology has become integrated into teaching-learning processes, it has been recognized that leveraging technology will result in a better student engagement as well as achievement of educational goals. (Ellis & Bliuc, 2016). The quality of students' learning approaches to

learning is largely dependent upon their perception towards the learning environment and the inherent motivational factors(Coertjens et al., 2016) An important manifestation of technology enhanced learning is online/blended learning which resulted as an emergency alternative to the outbreak of Covid-19(Yeung & Yau, 2022). TEL has led to a drastic change in the learning environment by offering a diverse range of online learning tools such as learning management systems, online courses, online classrooms, and assistive technology at affordable prices.

Casanova et al (Casanova et al., 2011) proposed *five* dimensions to evaluate the quality of Technology Enhanced Learning as: expectations and perceptions of the stakeholders, desired competencies of the teachers and learner to take part in TEL practices, the required learning environment and resources, assessment strategies and practices in line with the requirements of the course and required support from administration in terms of logistics and tools.

The existing paper would adopt a bibliometric approach to review the existing studies that have happened on TEL and would provide the researchers with scope for further research by focusing on the areas that are less researched. The main contribution of the study would be the proposed framework for TEL-based education and pedagogy to enhance the quality of education.

The chapter intends to answer the following research questions:

RQ1: What is the pattern of growth in a publication related to the TEL curriculum and pedagogy for quality education since 2000?

RQ2: What characteristics of authors and their productivity in the domain of TEL research?

RQ3: Which studies are instrumental in shaping the knowledge base of TEL and quality education since 2000?

RQ4: What is the association between TEL curriculum - pedagogy and quality education?

RQ5: Evaluate existing TEL integrated framework for quality education?

The increasing use of technology in education has gained attention from academician also and thousands of researchers are found on various aspects of TEL However, most of the research has specific focal point or limited to small sample. There is few research in which TEL is studied with the perspective of higher education (Shen & Ho, 2020) and secondary

education(Del Cerro Velázquez & Morales Méndez, 2018)Most of these studies focus on learning enhancement and competency from perspective of teacher (Baena-Morales et al., 2020), achievement from perspective of students(Tamim et al., 2011).Some of the studies on SDG 4 i.e. quality education are related to its perspective(Boeren, 2019) and multilevel governance analysis(Franco & Derbyshire, 2020) . There is a rare amount of research contribution which provides insight on TEL curriculum and pedagogy with the aim to achieve specific SDG.

This study fills the gap of the existing study by providing comprehensive view about various studies which have focused light on TEL curriculum and pedagogy for quality education, by discussing its performance, collaborative pattern, influential author, and studies. Based on previous literature, the study will also throw light on the various frameworks for TEL based curriculum and pedagogy as well as prospects for framework and research. The period of the study will be 2000-2022.

Research Methodology

Selection of Database

There are many data sources like Scopus, EBSCO, ProQuest, Inspec, and Web of Science. For the present study, On October 22,2022. through Scopus database the existing and available literature. Scopus Database as it is the most extensive database consisting of more than 22,000 journals across different disciplines (Bartol et al., 2014). The Boolean operator AND was used to execute the search with key strings “Technology Enhanced Learning” AND SDG4 AND Curriculum AND Pedagogy. The search was expanded with the Boolean operator OR with the key string (“Technology Enhanced Learning” OR “Education Technology”) AND (SDG4 OR “Quality Education”) AND Curriculum AND Pedagogy. The language selected was English. In addition to specify the search the option was enabled by title and keyword resulted into total 453 documents consisting of 367 articles, 2 book, 56 book chapters, 2 editorials, 1 note and 24 reviews from the period 2000-2022. The resulting database of 453 documents downloaded as CSV file is used for bibliometric analysis through Biblioshiny and VOS Viewer software.

The generated pool of 453 articles downloaded from the Scopus database was used for bibliometric analysis. The results are presented in four sections: 1) Characteristics and

Performance, 2) Influential Author and Document, and 3) Thematic Analysis. The visualization software used for the study is VOS Viewer(van Eck & Waltman, 2010) and Biblioshiny, a bibliometrics R package.

Results

Characteristics and Performance of TEL Research

RQ1: What are the characteristics and performance of green finance research for the past two decades?

The study inspects characteristics of 453 publications and analyses annual publication trend, annual citation performance, and geographical spread in TEL research. In the data retrieval process, the study has come across 453 publications on TEL from 2000-2022. Table 1 shows the overall characteristics of 453 TEL publications using Biblioshiny for R Studio.

Table 1. Overall Characteristics of TEL Publication

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	2000:2022
Sources (Journals, Books, etc)	232
Documents	453
Annual Growth Rate %	18.39
Document Average Age	6.47
Average citations per doc	13.52
References	19151
DOCUMENT CONTENTS	
Keywords Plus (ID)	1050
Author's Keywords (DE)	1455
AUTHORS	
Authors	1158
Authors of single-authored docs	108
AUTHORS COLLABORATION	
Single-authored docs	117

Description	Results
Co-Authors per Doc	2.89
International co-authorships %	0
DOCUMENT TYPES	
Article	367
Book	3
Book Chapter	56
Editorial	2
Note	1
Review	24

(Source- Extracted from Biblioshiny R)

Figure 1 shows annual Publication trend shows year on year increase in the research of TEL.

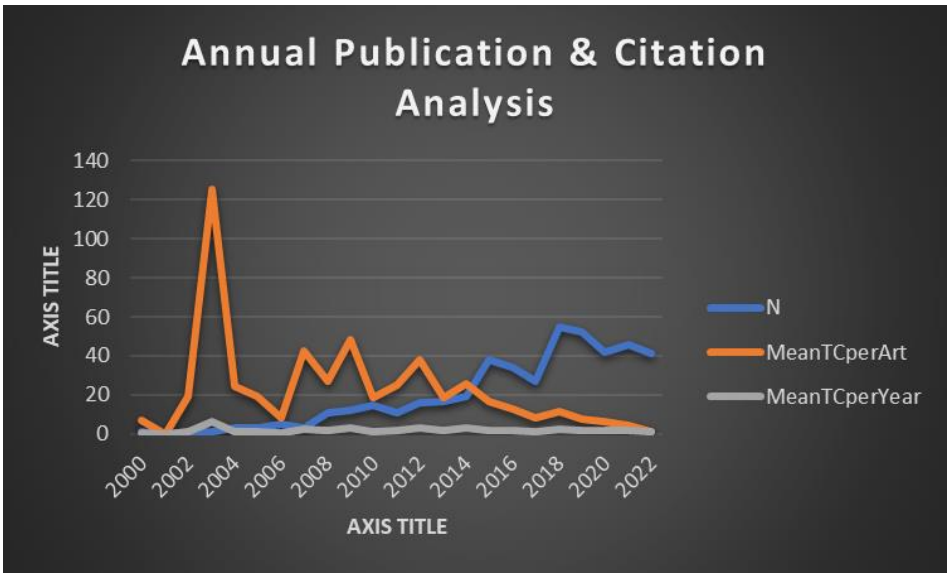

Figure 1. Annual Publication and Average Citation Analysis

Earlier the pursuit of higher education was elitist. The focus was knowledge for the sake of knowledge. But with massification of higher education with knowledge based and technology driven economy, the focus shifted to employability based education .(Gupta, 2021). The need to equip students with the skills which the market requires was realized. Early 2000 onwards the world was in era of digitalization. Technology has disrupted most of the sectors of the economy and changed our way of life. The Education Industry was no different. It also got impacted by the disruption. With the comparative advantages, relative to traditional

"chalk-and-talk" classroom instruction, TEL helped in scaling up standardized instruction, facilitating differentiated instruction, expanding opportunities for practice, and increase student engagement. When schools, colleges and universities use technology to enhance the work of educators and to improve the quality and quantity of educational content, learners will thrive. This has grabbed the attention of academicians also. That is the reason TEL based research and publication increased consistently.

Table 2. Annual Publication & Average Citation Trend

Year	N	Mean TC per Art	Mean TC per Year	Citable Years
2000	1	7.00	0.30	23
2001	0	0.00	0.00	0
2002	1	19.00	0.90	21
2003	1	125.00	6.25	20
2004	3	24.33	1.28	19
2005	3	19.33	1.07	18
2006	5	8.20	0.48	17
2007	3	42.67	2.67	16
2008	11	26.82	1.79	15
2009	12	48.08	3.43	14
2010	15	18.40	1.42	13
2011	11	25.18	2.10	12
2012	16	37.88	3.44	11
2013	17	18.76	1.88	10
2014	19	25.58	2.84	9
2015	38	16.84	2.11	8
2016	34	12.91	1.84	7
2017	27	8.11	1.35	6
2018	55	11.62	2.32	5
2019	52	7.73	1.93	4
2020	42	6.38	2.13	3
2021	46	4.20	2.10	2
2022	41	0.95	0.95	1

(Source- Extracted from Biblioshiny R)

RQ2: What characteristics of authors and their productivity in the domain of TEL research?

Table 3 shows a comprehensive assessment of the most influential authors in TEL research. The threshold limit is taken as at least one document with a minimum of 50 citations. Out of 1158 authors 81 met the threshold. The first 10 authors having the highest citation are considered for analysis Figure 2.

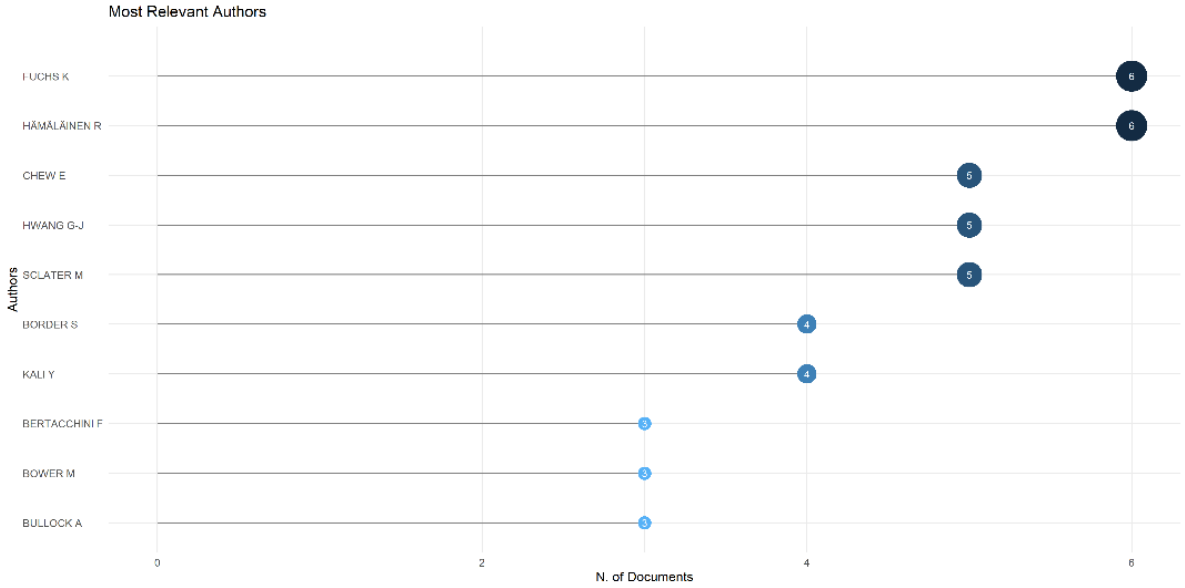

Figure 2. Influential Authors Publication Analysis

(Source-Extracted from Biblioshiny R)

Dr Dillenbourg Pierre of EPFL Switzerland's forte of research in collaborative learning. (P. Dillenbourg & Tchounikine, 2007; Pierre Dillenbourg et al., 2009), and later integrating it with learning technologies as melting into a beam of educational tools, (Pierre Dillenbourg, 2008)integrated within many other pedagogical activities that the teacher orchestrates(Pierre Dillenbourg, 2008). (Pierre Dillenbourg et al., 2009). Sanna Jarvela of University of Oulu along with Dr Dillenbourg Pierre and Frank Fischer of University of Munich, Germany researched on evolution of computer based collaborative learning (Pierre Dillenbourg et al., 2009), Dr Nati Cabrera Lanzo , University Oberta de Catalunya, Spain has focused on integrating concept of inclusive learning with e- learning(Sangrà et al., 2012), Dr Dimitrios Vlachopoulos area of interest is critical analysis of technology-enhanced learning(Bower & Vlachopoulos, 2018) pedagogy in education(Essel et al., 2021; Vlachopoulos & Makri, 2017) quality of education technology and curriculum(Vlachopoulos, 2016) online transformation of education(Essel et al., 2020).Dr Yael Kali brought together in an ecological framework

that can be used by researchers to study teacher design knowledge and work across projects. This synthesis could also provide an articulated framework for developers and facilitators of teacher professional development programs for identifying key areas for support to teacher-designers in specific settings.(Kali et al., 2015).

Table 3. Influential Authors Publication Analysis

id	Author	Documents	Citations	Affiliated Institution	Country
1	Dillenbourg Pierre	2	465	Ecole Polytechnique Fédérale de Lausanne	Switzerland
2	Jarvela s.	2	426	University of Oulu	Finland
3	Fischer f.	1	416	University of Munich	Germany
4	Cabrera n.	1	236	University Oberta de Catalunya	Spain
5	Sangrà a.	1	236	University Oberta de Catalunya	Spain
	Vlachopoulos d.	1	236	Erasmus University Rotterdam	Netherland
7	kali y.	4	180	University of Haifa	Israel
8	Mckenney s.	2	166	Open University of Netherland	Netherland
9	barsom e.	1	155	Academic Medical Centre	Netherland
10	christoph n.	1	155	Academic Medical Centre	Netherland

(Source: Author's Compilation)

RQ3: Which studies are instrumental in shaping the knowledge base of TEL and quality education since 2000?

The study conducts citation analysis of influential articles using Vos viewer. We have considered those influential articles which have got at least 50 citations. Out of 453 documents 27 met the threshold. (Figure 3). Based on citation and cross-referencing Table 4 shows the top 10 most influential documents. The research focus of top cited documents are mainly on evolution and development of TLE(Pierre Dillenbourg et al., 2009; Sangrà et al., 2012).The field in which TEL is researched more is medical education(Hardyman et al.,

2013; Moule et al., 2010). Recent researchers investigated the effect of different instructional designs using computer supported collaborative concept mapping on students' conceptual understanding, focusing on the type of processes of knowledge co-construction that students engage (Farrokhnia et al., 2019) and role of informal digital learning in developing digital competency (Mehrvarz et al., 2021).

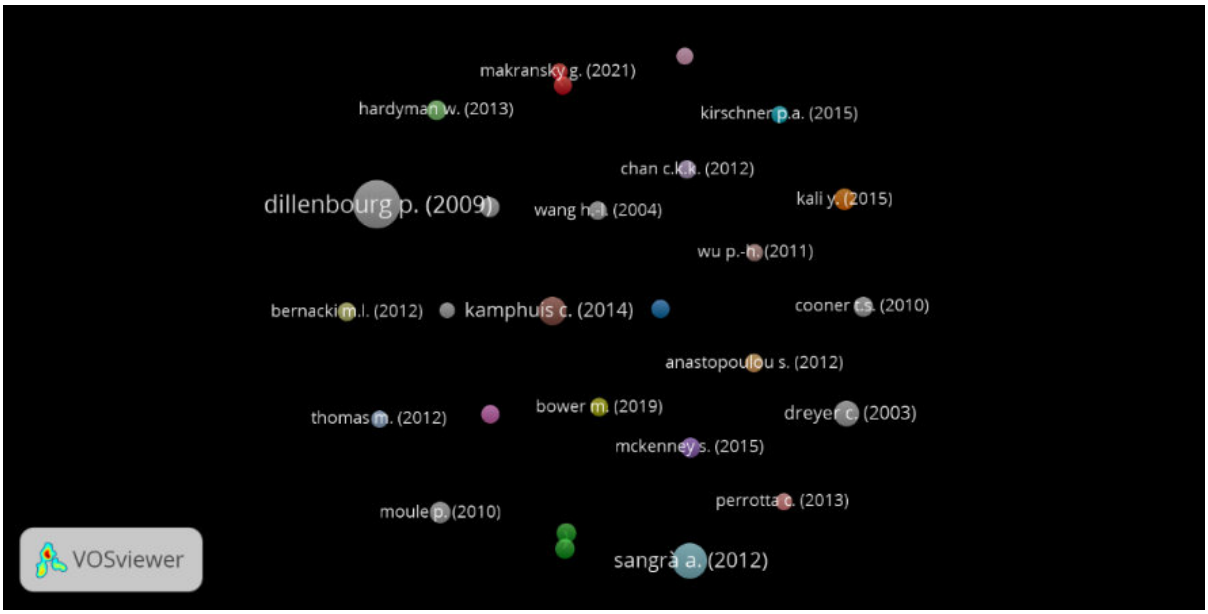

Figure 3. Citation analysis -Document Wise

(Source-Extracted from Vos-viewer)

Table 4. Influential Document Analysis

No.	Title	Authors	Name of the Journal	Citation	Year
1	The Evolution of Research on Computer-Supported Collaborative Learning	Pierre Dillenbourg, Sanha Jarvela and Frank Fischer	Technology Enhanced Learning, Principle & Products	416	2009
2	Building an inclusive definition of e-learning: An approach to the conceptual	Albert Sangrà, Dimitrios Vlachopoulos and Nati Cabrera	International Review of Research in Open and Distance	236	2012

No.	Title	Authors	Name of the Journal	Citation	Year
	framework		Learning		
3	Augmented reality in medical education?	Caroline Kamphuis, Esther Barsome,Marlies Schijven, Noor Christoph	Perspective in Medical Education	155	2014
4	Teaching reading strategies and reading comprehension within a technology-enhanced learning environment	Carisma Dreyer, Charl Nel	System	125	2003
5	Teachers as designers of technology enhanced learning	Yael Kali, Susan Mckenney,Ornit Sagy	Instructional Science	87	2015
6	Nursing and healthcare students' experiences and use of e-learning in higher education	Pam Moule, Rod Ward, Lesley Lockyer.	Journal of Advanced nursing	83	2010
7	Teacher design knowledge for technology enhanced learning: an ecological framework for investigating assets and needs	Susan McKenney, Yael Kali, Lina Markauskaite & Joke Voogt	Instructional science	79	2015
8	Mobile technology supporting trainee doctors' workplace learning and patient	Wendy Hardyman, Alison Bullock, Alice Brown, Sophie	BMC Medical Education	77	2013

No.	Title	Authors	Name of the Journal	Citation	Year
	care: an evaluation	Carter-Ingram & Mark Stacey			
9	Academic workload: the silent barrier to the implementation of technology-enhanced learning strategies in higher education	Mary Sarah-Jane Gregory, Jason Michel Lodge	Distance education	75	2015
10	Modelling benefits-oriented costs for technology enhanced learning	Diana Lorillard	Higher education.	74	2007
11	Computer-supported collaborative concept mapping: The effects of different instructional designs on conceptual understanding and knowledge co-construction	Farrokhnia, Mohammadreza Pijeira-Díaz, Héctor J. Noroozi, Omid Hatami, Javad	Computers & Education	82	2019
12	The mediating role of digital informal learning in the relationship between students' digital competency and their academic performance	Mehrvarz, Mahboobe Heidari, Elham Farrokhnia, Mohammadreza Noroozi, Omid	Computer & education	73	2021

(Source- Author's Compilation Based on Data)

RQ4: What is the association between TEL curriculum - pedagogy and quality education?

Keywords are significant indicators of the growing research trends among academicians and authors across the globe. Keyword analysis can be performed using the index, author, and author-index keywords. We have considered the author keyword as a threshold for the present study. The author's keyword is essential for identifying research trends, gaps, and exciting research areas. Out of 1455 author's keyword 48 meet the threshold of minimum 5 times occurrence. Figure 4 shows the result of Keyword co-occurrence analysis. Table 5 presents first 25 keywords based on occurrences/ The essential key words identified along with technology enhanced learning (Occurrence:269) are higher education(O:24m TLS: 40),e-learning (O: 24, TLS: 37), online learning(O:19,TLS :34), blended learning(O: 19,TLS 31) , collaborative learning (O:10 , TLS: 21), active learning (O: 14, TLS : 18) and inquiry based learning(O:8. TLS: 13) Most of the researches related to TEL are related to educational approach, a very few keywords related to curriculum and pedagogy identified in past research..

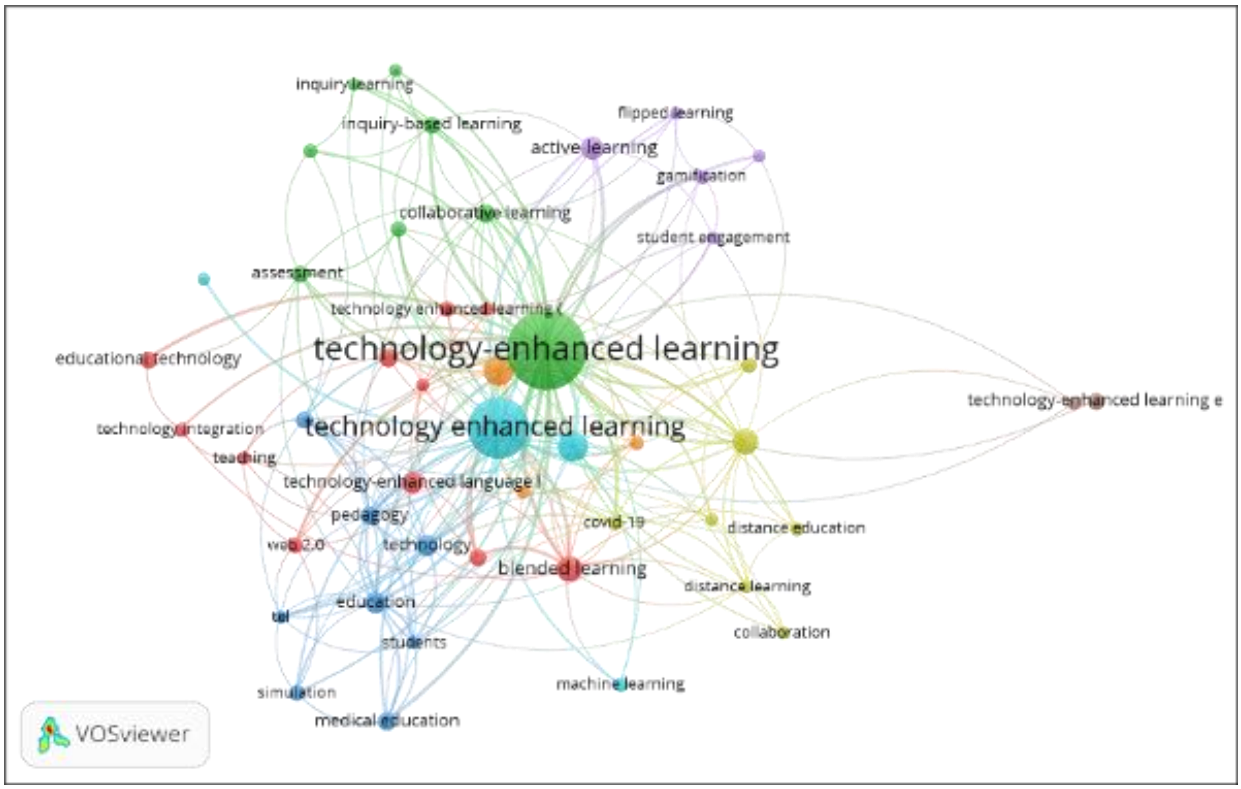

Figure 4. Co-occurrence analysis (Author's Key Word)

(Source- Extracted from Vosviewer)

Table 5. Keyword Co-occurrence Analysis

Id	Key word	Occurrence	Total Link strength
1	Technology-Enhanced Learning	172	156
2	Technology Enhanced Learning	103	89
3	E-Learning	24	37
4	Higher Education	24	40
5	Blended Learning	19	31
6	Online Learning	19	34
7	Active Learning	14	18
8	Education	13	34
9	Technology	13	19
10	Technology-Enhanced Language Learning	13	6
11	Collaborative Learning	10	21
12	Medical Education	10	21
13	Pedagogy	10	31
14	Technology-Enhanced Learning (Tel)	10	9
15	Assessment	9	15
16	Flipped Classroom	9	14
17	Learning	9	18
18	Technology-Enhanced Learning Environments	9	3
19	Educational Technology	8	8
20	Inquiry-Based Learning	8	13
21	Mobile Learning	7	12
22	Professional Development	7	12

Id	Key word	Occurrence	Total Link strength
23	Simulation	7	12
24	Technology Enhanced Learning (Tel)	7	8
25	Web 2.0	7	10

(Source: Extracted from Vos viewer)

Thematic Analysis

Bibliographic Coupling

The idea of bibliometric coupling was coined by Kessler (Kessler, 1963). Kessler explained in bibliometric analysis that scientific publication shows intellectual association with referencing pattern, wherein scientific publication that cites similar sources show an intellectual association. In that sense, the bibliographic coupling can be predicated as articles with the exact referencing will have similar content. The bibliometric Coupling map of the document is shown in Figure 5. Out of 453 publications, 52 meet the threshold of 30 citations. For each 52 items, TLS is calculated, and based on the strength, 42 items are selected. These 42 items are divided into 8 clusters. The top 3 Clusters have 6(red),6(green) and 6(blue) items. The research area of the top 3 cluster are discussed below.

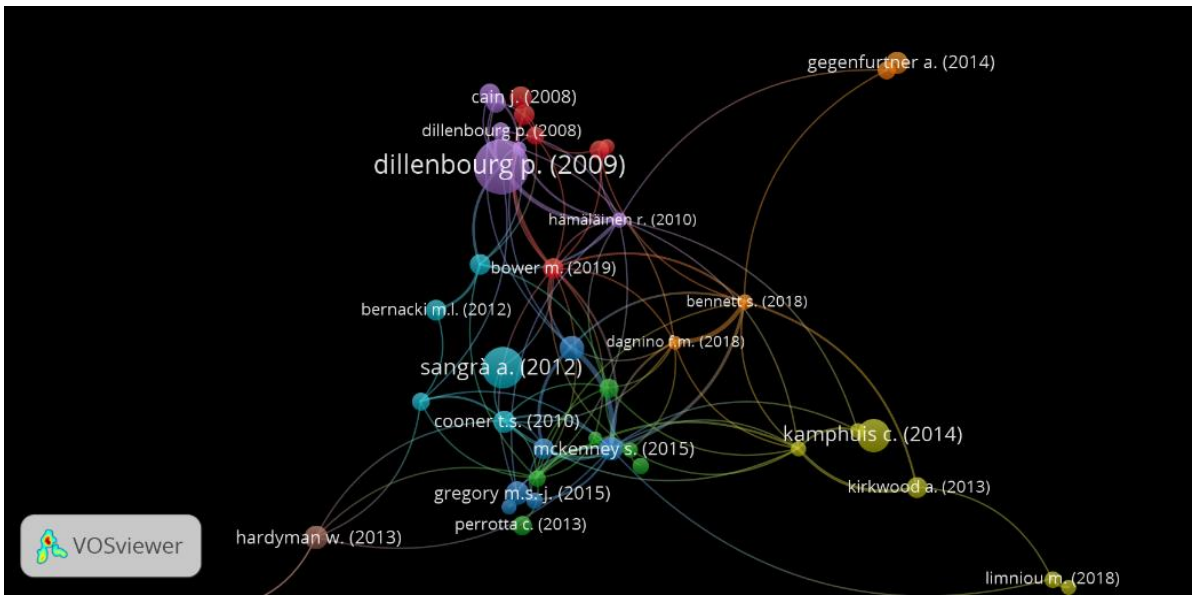

Figure 5. Bibliographic Coupling

(Source-*Extracted from Vosviewer)*

Cluster 1(TEL Perspective in Learning)

Cluster one consists of 6 items and has been cited 325 times. The articles in this cluster discuss synthesizing and understanding of learning in context of TEL. The researches highlights that TEL is a significant associative tool for mediating learning(Bower, 2019). Reflection or deep learning requires specific support. TEL is recognized as effective facilitator the supports student as well as group learning. (Kori et al., 2014; Kyprianidou et al., 2012) The researches describes affective and cognitive factors that can lead to TEL-Immersive Virtual Reality based learning includes interest, motivation, self-efficacy, embodiment, cognitive load, and self-regulation.(Makransky & Petersen, 2021).

Cluster 2 (Teacher's Perspective for TEL)

Cluster 2 consists of 6 items and has been cited 249 times. The cluster discusses about experience of teacher ability to integrate technology in pedagogy.(Doering et al., 2014; Perrotta, 2013) .The authors used a mixed-methods design employing surveys and observations to evaluate teacher experiences within a professional development program focused on developing in-service geography teachers' technological, pedagogical, and content knowledge (TPACK) through content-specific learning tools and resources. (Fabregat-Aibar et al., 2019; FitzGerald et al., 2018) Extending the discussion personalization is considered as positive phenomenon and authors have proposed frame for personalized TEL. Digital stories are researched as enabler for knowledge cocreation and helped teachers critiquing the usability, usefulness, efficacy and flexibility of the technologies(Parsons et al., 2015).The efficiency of workplace based feedback and assessment in professional education can be enhanced by E-Portfolio by learning analytics (van der Schaaf et al., 2017).

Cluster3 (TEL Implementing Perspective)

Cluster 3 consists of 6 items and has been cited 373 times. This research cluster emphasis on TEL implementing perspective. The practices like pedagogy first approach to encourage use of, and experimentation with, technology within teaching practice and to promote the mainstreaming of innovative practice(Glover et al., 2016). At the same time for many decades teachers are identifies as sculptors for curriculum designing , so in the era of digitalization , teachers can play a significant role in utilizing knowledgebase to design

TEL(McKenney et al., 2015).The implementation of TEL is seen as a tool for intellectual expression and linked with educational aim, relation between innovation and practices user engagement and flexible workload.(Gregory & Lodge, 2015; Laurillard et al., 2009).

Trending Topic

The study identifies trending topics of the last five years using Biblioshiny. Figure 6 shows the plot of trending topic. In the last 5 years the research related to TEL is concentrated around curriculum, machine learning and virtual reality. With predictions that virtual reality (VR) and related technologies could reach 15 million learners by 2025 (Goldman Sachs 2018), the number of research studies related to VR is rapidly rising. A literature search shows that the number of studies on Scopus that suggest VR in combination with either teaching-learning, imparting education, or training is rapidly rising(Makransky & Petersen, 2021) Not only conventional and regular education but education related to fine arts like music violin and sports also uses TEL-machine learning to enhance efficacy.(Dalmazzo & Ramírez, 2019).

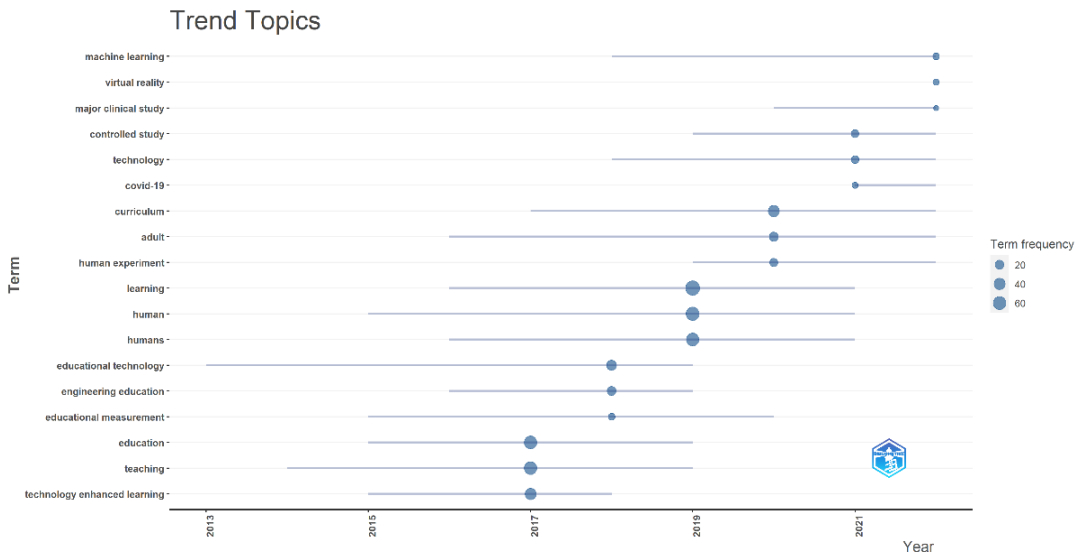

Figure 6. Trending Topic

(Source: Extracted from Biblioshiny R)

Thematic Map (Based on Authors Keywords)

To identify the themes and different themes discussed among the identified research papers,

the study draws a thematic map using the R studio Biblioshiny package with a frequency of 10 per thousand words and number of words 150. The technique helps to map main themes into four quadrants, according to their centrality and density rank, along with the X and Y axis. Centrality is a measure of an essential theme in research, whereas density measures the development of a theme based on the internal strength of the network. The four quadrants are Basic (High-centrality and Low Density), Motor (High-centrality and High Density), Niche (Low-centrality and Low Density), and emerging & declining theme (Low-centrality and High Density) (Ghasemzadeh et al., 2022). The motor themes are well-developed and contain the critical structure of the research. Niche themes are specialized and well-developed research themes of the research area. The third quadrant is emerging or declining themes, and the fourth quadrant, i.e., basic themes, covers important themes that require development. The thematic map of TEL shows in Figure 7 that the burning themes (motor theme) for researchers are virtual reality, augmented reality web 2, game-based learning, pedagogy and reflection education. Whereas other tools of TEL like blended learning, collaborative learning active learning technological assessment and higher education are themes of relevance but there lot of scope research in these area (Basic theme).Technology based language learning ,distance learning, students feedback are niche area of research while self-regulated study and work place learning are emerging or dying area of study.

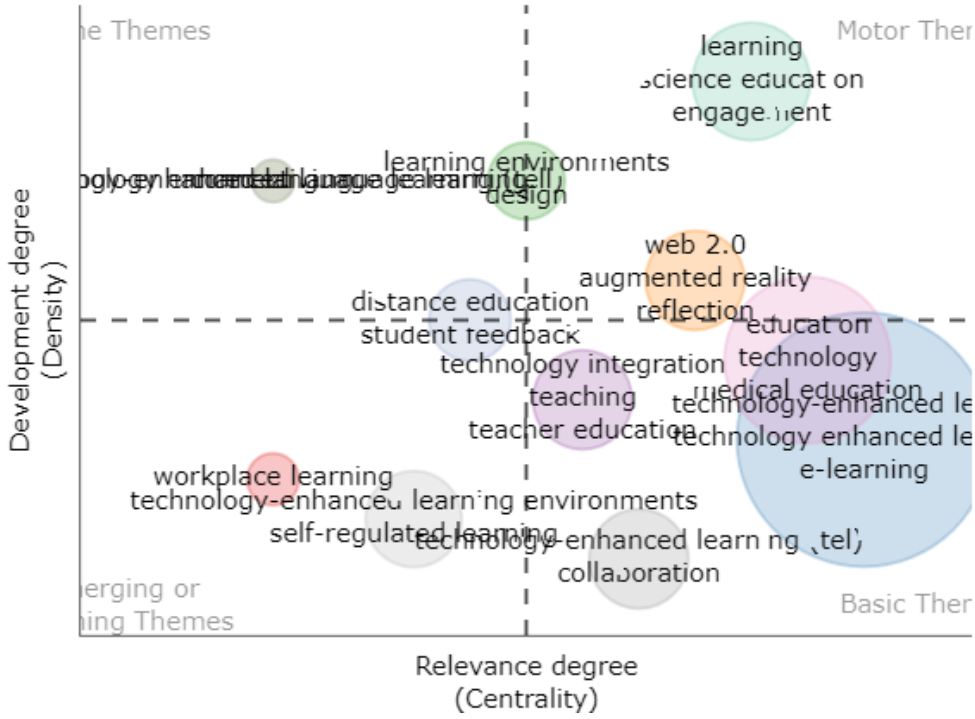

Figure 7. Thematic Analysis

(Extracted from Biblioshiny R)

Conceptualizing and Discussion on TEL Pedagogy for Quality Education

Practices like pedagogy first approach to experiment with, technology within teaching practice and to promote the mainstreaming of innovative practice is the requirement of TEL. At the same time for many decades teachers have been identified as sculptors for curriculum designing, so in the era of digitalization, teachers can play a significant role in utilizing knowledgebase to design TEL. The implementation of TEL is seen as a tool for intellectual expression and linked with educational aim, relation between innovation and practices, user engagement and flexible workload. A reflection or deep learning requires specific support. TEL is recognized as an effective facilitator the supports students as well as group learning. The research describes affective and cognitive factors that can lead to TEL-Immersive Virtual Reality based learning includes interest, motivation, self-efficacy, embodiment, cognitive load, and self-regulation.

The attainment of Sustainable Development Goal 4, which aims to guarantee inclusive and equitable quality education while promoting lifelong learning opportunities for all, holds a pivotal position in constructing sustainable, inclusive, and resilient societies.(UNESCO, 2019). This goal supports the reduction of disparities and inequities in education, both in terms of access and quality. The researchers opined success of technology depends on dimensions of TEL. TEL can improve dimensions of knowledge by different knowledge perspectives. The role of technology in education can be approached through the lens of educational sustainability, considering its contribution to fostering a sustainable environment. Additionally, it can be evaluated based on how technology usage aids in accomplishing various sustainable development objectives, such as promoting equal educational opportunities across all segments of society.(Daniela et al., 2018; Visvizi & Daniela, 2019). Similarly, the presence of technology in education can serve as a catalyst for fostering inclusive education and an inclusive society. It achieves this by aiding students with particular learning requirements and by creating opportunities for students to gain knowledge that would otherwise be unattainable without technological aid.(Rodriguez-Ascaso et al., 2011).Further technological process can help in acquiring and creating knowledge along with enhancing learning process(Ifenthaler & Yau, 2020; Zhu et al., 2016).

So the TEL has all substance to achieve access and quality education of SDG 4. TEL can help education in reaching nuke and corner of world through various platforms and ICT tools. The

other aspect of quality can be attained through orchestrating TEL pedagogical activities. The process can be termed as “Smart Pedagogy”. The term "smart" pertains to the utilization of digital technologies within the learning process(Visvizi & Daniela, 2019).. This concept of smart pedagogy takes the forefront in Technology-Enhanced Learning (TEL), aiming to examine the necessary pedagogical activities that contribute not only to a technology-rich learning experience but also to improved learning outcomes and enhanced access to knowledge. Consequently, smart pedagogical competence acts as a driving force to ensure that technology integration in classroom activities holds pedagogical significance, thereby facilitating technology-enhanced learning.

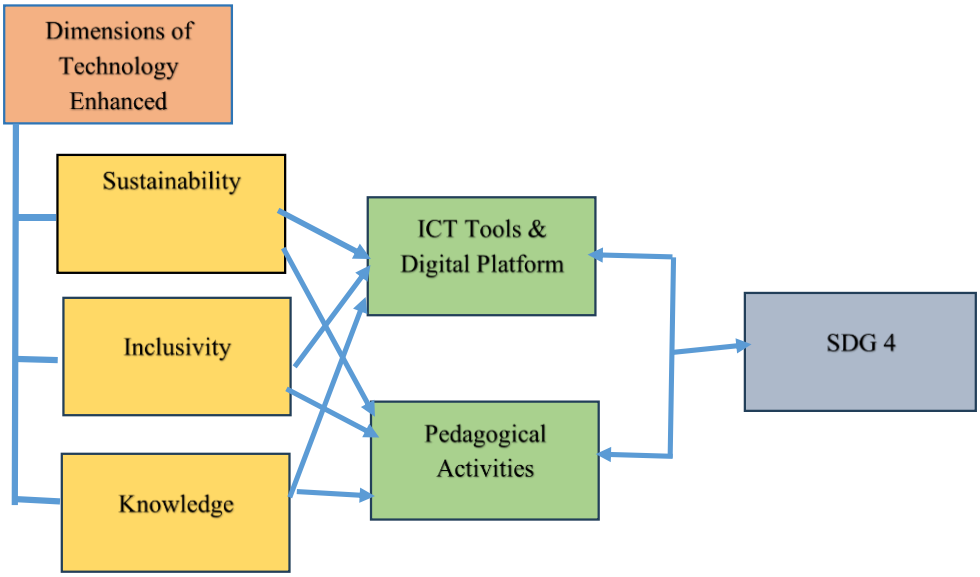

Figure 8. Technology Enhanced Learning and SDG4

(Source: Adapted from existing studies)

TEL pedagogy addresses the current issues associated with the education system. UN defined 17 SDG 4 as quality education and world become self-reliant in technology, it becomes imperative to develop such TEL curriculum and pedagogy which can help countries attain SDG 4. The curriculum and pedagogy require to enable, educate and empower every learner knowledge as well as knowledge associated by technology. The learning model requires :1) capacity building 2)development of instructional objective to provide purpose ,motivation and direction to learners, 3)Instructional objectives should be at par with real world and it should fill the gulf between real world and education offered.(Sherly & Uddin, 2010). The past researches advocates collaborative learning as a method for quality

education(Kali et al., 2015; Kyprianidou et al., 2012; Vlachopoulos & Makri, 2017).There are various model suggested by past researcher which can integrate technology with curriculum and pedagogy. One of such models is problem-based learning in two approaches. One of the approach suggests learning /implementing PBL to concurrent to technology skill ,however the other approach advocates learning PBL before technical skills.(Walker et al., 2010). The other model emphasises the development of technological pedagogical and content knowledge (TPACK) via content-specific learning tools and resources. According to the findings, instructional scaffolding plays an important role in improving teachers' ability to integrate technology in pedagogically meaningful ways that improve students' inquiry skills..(Doering et al., 2014).Based on course a model suggests collaborative learning approach using technology.(Domalewska, 2014; Noroozi et al., 2012). Gamification is argued to be fun and enjoyable method to support quality education(Dehghanzadeh et al., 2021).Thus, various pedagogical approach as required by the course is well accepted with integrated technology. Nevertheless, whichever the model teacher play pivot role in orchestrating technology in curriculum, content and pedagogy.(Pierre Dillenbourg et al., 2009).

Conclusive Remarks

Summarized findings of the studies are discussed as follows:

- These 453 studies were drafted by 1158 authors.
- Documents selected for the study have received on average fourteen citations.
- Twenty-three percent of the documents are contributed by the single author and seventy seven percent of the documents is the result of collaboration between the authors.
- Overall assessment shows that on an average twenty percent of the new research studies have been published enriching the relationship between technology enhanced learning and quality education across the globe.
- Technology enhanced learning, e-learning, higher education, blended learning, and online learning are the most influential keywords in our assessment.
- Contribution from developing countries and developed countries is significant, still the maximum research productivity is from developed countries.
- International collaboration between the authors and associations is found to be negligible, most of the collaboration between the authors and institutions is domestic

or local level.

- Analysis of bibliographical coupling shows that TEL perspective in learning and researchers' perspective in learning are mostly discussed topics by the academic fraternity.
- Most influential studies are contributed by influential authors like Pierre Dillenbourg, Sanha Jarvela, Frank Fischer, Albert Sangrà, Dimitrios Vlachopoulos, Nati Cabrera.
- Most influential institutions that have contributed to the domain are Ecole Polytechnique Fédérale de Lausanne, University of Oulu, University of Munich, and Academic Medical Centre.
- In terms of the nature of studies most of the studies are conceptual and empirical in nature. There are very few studies that have done systematic review of the domain.
- Co-authorship analysis shows that authors have formed collaboration within and between the institutions of their own country.
- Twenty-two percent of the research output is from the USA alone.
- SDG Four and TEL has attracted research contributions from across the globe. In total, 48 countries contributed to the knowledge domain through their scientific contribution.
- Most of the authors, institutions, and countries have contributed once or twice to the knowledge domain.
- Academicians have contributed most of the research output on the interlinkage between TEL and quality education in comparison with practitioners.
- Practitioners have also contributed to the research domain, but their contribution is limited in number.
- The importance of TEL and technology management is appreciated in different educational levels consisting junior level to the higher level of studies.
- Most of the authors, institutions, and countries have contributed once or twice to the knowledge domain.
- Academicians have dominated IJPM research in comparison with practitioners.
- Practitioners have also contributed to the research domain, but their contribution is limited in number.

Limitations of Study

Our study has recognized a few limitations. They are discussed as follows:

- Since our focus was to incorporate the interlinkage between TEL and quality education for the past 22 years of research studies, we have not offered detailed propositions linking the elements, which would be a logical next step.
- Scopus assigns one-unit value to each author, study, institution, country, and publication. This implies that one study has an author; it will have the same value as if it had two or more authors.
- Database like Web of Science, EBSCO, PROQUEST are not considered while filtering out the necessary articles.
- The study has not discussed the conceptual model and proposed relationship between the identified factors.

Future Implications

- In future we wish to develop the conceptual model and define the relationship between identified factors through empirical relationship.
- The relationship between TEL and its applicability in the higher educational institutes can be further explored.
- The role of digital teachers in a global economy can be explored as there is a growing attention across the globe about digital economy.

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