

Systematic review on digital transformation among teachers in public schools

Nor Asiah Razak¹, Roznim Mohamad Rasli¹, Suvarmani Subhan², Nor Aniza Ahmad³, Shazia Malik⁴

¹Faculty of Computing and Meta-Technology, Universiti Pendidikan Sultan Idris, Tanjong Malim, Malaysia

²Ministry of Education, Putrajaya, Malaysia

³Faculty of Educational Studies, Universiti Putra Malaysia, Serdang, Malaysia

⁴Institute of Education and Research, University of the Punjab, Lahore, Pakistan

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ABSTRACT

Radical changes across almost all areas, including education, due to the COVID-19 outbreak. One of the rapid transformations is digital learning, also known as e-learning. Digital learning transformation has been taking place for more than a decade. However, little comprehensive analysis of digital transformation in teaching in public schools. To the best of the authors' knowledge, no comprehensive analysis incorporates external and internal barriers and examines the prominent theories to study successful e-learning integration among teachers. The aim of this study was to provide a thematic and theoretical understanding of digital learning transformation among teachers in public schools. The data for the study was acquired from the Scopus databases. The study employed content and comparative analysis and advocated a grounded theory approach to inductively analyze and criticize the theme construction for answering two research questions. Based on a set of criteria to determine whether each derived study should be included or excluded, 42 articles were reviewed between 2010 and 2022. The analysis uncovered 10 themes of antecedents that were constructed as a framework based on the first-second-order barriers. Results also indicated that CHAT, TPACK, TAM, and UTAUT are the most prominent theories used to conduct digital transformation research. The findings offered significant implications for digital transformation and educational technology communities, especially for policymakers to strategize and reflect on the practice they implemented and improvised if necessary for future sustainable education and efficient teachers' performance in teaching.

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Corresponding Author:

Nor Asiah Razak

Faculty of Computing and Meta-Technology, Universiti Pendidikan Sultan Idris

35900 Tanjong Malim, Perak, Malaysia

Email: norasiah.razak@meta.upsi.edu.my

1. INTRODUCTION

Radical changes across almost all areas, including education, due to the Coronavirus (COVID-19) outbreak. One of the rapid transformations is digital learning, also known as e-learning. E-learning involves utilizing digital tools that can help teachers be more creative and productive in their teaching while allowing students to learn at their own pace. Due to the availability of technologies connecting students with teachers, peers, and experts across huge distances and at any time, e-learning occurs outside the classroom [1]. Students can use social media sites such as Facebook and Twitter to communicate and collaborate and engage in e-learning environments via Webex, Zoom, and Google Meet. Students also can access educational resources, such as virtual reality (VR) and augmented reality (AR) subject contents, through the Massive

Open Online Courses (MOOCs) platform [2]. Hence, e-learning is an environment to support teachers in teaching with innovative teaching methods and allows students to learn anywhere and at their own pace to acquire and create knowledge.

To the best of the authors' knowledge, digital learning transformation has been taking place for more than a decade. Due to the role of digital transformation in learning is vital, a significant investment in e-learning takes place at schools worldwide. However, a tremendous asset in the digital transformation does not guarantee that teachers will adopt it for the teaching and learning (T&L) [3]. For example, empirical evidence in Indonesian schools demonstrated that more than 50% of the teachers did not manifest the critical needs of 21st-century learning during the pandemic [4]. This study found that most teachers' instruction adopted a teacher-centered approach (59.17%) even though the medium for teaching is online learning.

Recent available literature investigated advanced economies as Australia has not observed any positive programs at schools to encourage teachers to integrate e-learning, which will affect the teachers' confidence in teaching e-learning [5]. A study in the US revealed that some teachers might struggle to select an appropriate digital tool for conducting e-learning. In addition, teachers update their subjects' content but rarely modify their teaching approach [6]. Based on all the empirical evidence revealed by these researchers, not all teachers utilize e-learning to acquire a deep understanding of students. Thus, schools need to initiate organizational change by concentrating on an e-learning strategy to offer an achievable goal to the important stakeholders, particularly teachers, who shape the digital culture among them [1], [7].

2. LITERATURE REVIEW

2.1. The COVID-19 Pandemic and the accelerated digital transformation in education

Over millions of students worldwide cannot go to school due to measures to stop the spread of COVID-19. School closures have been implemented in 188 countries, and more than 1.7 billion students and their families are waiting for their T&L [8]. This situation reflects 94% of all students worldwide, from kindergarten to higher education [9]. COVID 19's negative effects quickly manifest in the form of probable learning loss [10]. However, COVID-19 cannot be taken as an aspect that hindered our progress. Therefore, the Ministry of Education in every country instructed all the educators, including teachers, to transform conventional teaching into digital or open distance learning (ODL). ODL is one of the approaches of e-learning for students worldwide able to learn at anytime and anywhere, especially during a pandemic or natural disasters like a flood or a student who was in the hospital or out sick for an extended period.

E-learning is an innovative teaching method for proficient students' 21st-century skills through student-centered learning characteristics. E-learning should be conducted in an active learning environment for students to engage in meaningful and authentic learning [11]. Students' engagement with e-learning depends on the designation of lesson plans with digital learning tools in relation to the principles of 21st-century skills leading to a student-centered approach to meaningful learning [12]. Student-centered learning is using digital tools to engage students in authentic, challenging, multidisciplinary tasks by providing realistic, complex environments for student inquiry, providing information and digital tools to support an investigation and connecting classrooms for joint investigations [13]. Personalized learning, competency-based learning, learning that takes place at any time and place, and students taking responsibility for their learning are all examples of student-centered learning. As a result, the COVID-19 pandemic has the potential to strengthen and accelerate the present digital transformation in education.

Many strategies have been used by stakeholders for digital transformation in education in the past decades. A systematic study in Mainland China by Luo *et al.* [2], who synthesized published empirical research on early childhood teachers, revealed digital tools used for pedagogical aspects for various purposes of students' learning. For example, video to develop teachers' skills to integrate into the curriculum, and humanoid robots and non-screen-based robotics to support children's learning. Another quantitative study in Russia on 420 respondents involved three groups of stakeholders, namely administrative staff, teachers, and students [14]. This study revealed positive trends for digital transformation strategy use, namely mobile learning to develop student's skills in research. A qualitative study in Russia on 61 teachers focused on mobile learning to enhance collaborative, problem-solving, creative learners & innovative, and active citizens [15]. Digital transformation strategies provide a positive impact on students, such as time-consuming, easy, fun, and technology-enhancement. However, digital transformation also brings drawbacks, such as cost, laziness, technical issues, humanistic, and social isolation [16].

In conclusion, technology is emerging and rapidly changing. Therefore, whatever the purpose of the use of digital tools in teaching, teachers should consider the volatility and complexity of an ever-changing skill set when integrating digital tools into the curriculum as teaching are dynamics that represent an approach toward digital innovation. Teachers are always encouraged to participate in professional development programs and improve their knowledge and abilities.

2.2. Barriers implementing digital transformation in education

Available literature manifests that barriers to the implementation of digital transformation among teachers are one of the negative impacts on the education sector [4], [6]. There are two kinds of barriers that digital investment managers need to ponder when integrating e-learning among teachers in developed and developing nations. Firstly, the first-order barriers, and secondly, the second-order barriers. Consequently, minimal e-learning was implemented for first-order barriers [1], [6], and for second-order barriers, minimal e-learning was implemented [17], [18].

The first-order barriers, according to Ertmer *et al.* [19], are “outside” the teacher, like training, technology resources, and support. Meanwhile, the second-order barriers are “within” the teacher, like teachers’ confidence, beliefs about how learners gained knowledge, and their views on technology use in T&L. In this context, the current study aims to develop a systematic literature review on successful digital learning transformation among public school teachers, published between 2010 and 2022 and indexed in the SCOPUS databases. However, little comprehensive analysis of successful teachers’ digital transformation in learning in public schools.

To the best of the authors’ knowledge, no comprehensive analysis incorporates internal and external antecedents to teachers implementing e-learning in teaching. In this sense, this article analyzed both the barriers to knowledge discovery and theoretical comprehension of the precursors [19], motivating teachers to embrace digital transformation and successfully implement e-learning in public schools. For example, a systematic literature review on digital transformation focuses on the readiness of Chinese early childhood teachers in China [2]. Therefore, the current study aims to fill the gap identified in the existing literature. Thus, the primary purpose of the present study is to undertake a systematic literature review of empirical studies that have been published with a focus on teachers’ digital transformation in education. The outcome of this systematic review is on the concepts of successful digital transformation and theoretical understanding by examining the external and internal barriers to teachers’ digital transformation in public schools as described in the available literature. By understanding the concepts, researchers will be able to inform educational technologists, policymakers on digital utilization, and academic players on successful strategies for e-learning implementation, particularly in third-world countries where there is a lack of awareness about successful e-learning implementation in public schools.

To facilitate the systematic literature review process, there were two research questions of the study: i) What key themes can emerge from the empirical studies to resolve the first-second-order barriers to successful e-learning implementation among teachers in public schools?; and ii) How are prominent theoretical frameworks or digital transformation models applied in empirical studies on the successful e-learning implementation among teachers in public schools? We then explained the themes underpinned by [19], [20] first- and second-order barriers to address the first research question. Then, discuss the theoretical gaps to address the second research question. Lastly, we discussed the limitations and implications for the research community to manage digital investment in the COVID-19 era by looking at the teachers' successful implementation of e-learning.

3. RESEARCH METHOD

3.1. Systematic review

A systematic review was carried out between 2010 and 2022 related to teachers’ e-learning integration into teaching in public primary or secondary education. The studies were reviewed further based on their relevance to the topic and eligibility. The exclusion and inclusion characteristics were used to read abstracts to rule out articles that did not meet the criteria. The researchers employed a constant comparative technique to seek published empirical research that allowed us to compare the results. The findings were reported after the research gaps were established, as the findings highlighted the direction for future research.

3.2. Data collection

Following the URL <https://www.scopus.com/>, we ran a structured search technique to retrieve peer-reviewed articles from Scopus databases such as Emerald, Springer, ScienceDirect, SAGE, EBSCOHost, and ERIC. The authors’ university library is linked to these databases. The well-known publishers are significant for this paper because the publications chosen would enable the production of a review with valid and reliable findings. We formulated three inclusions and two exclusions for the review. As exhibited in Table 1, every article must meet the search technique's inclusion and exclusion criteria. We applied the “AND” and “OR” operators to seek word combinations like “e-learning integration” “primary schools”, “secondary schools”, and “e-learning in education” and “technology”. We searched until we were completely exhausted (i.e., locating similar articles using various search term combinations).

Table 1. Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
i) All articles documenting the studies carried out in public school settings, including studies that dealt with e-learning integration (the informant sample in the study can be from primary and secondary schools).	i) Articles that were not peer-reviewed because it is important that the review obtained results from credible research.
ii) Research articles or original articles which were peer-reviewed before being published permitted us to compare results among studies and gained higher-order thematic classifications.	ii) Articles in which no explicit method of data collection were reported.
iii) One of the samples must be teachers, as the study focused on teachers' perception in regard to e-learning integration, as well as on teachers' professional development.	

Following the database search, the abstracts of each article were evaluated to ensure that the articles' potential for e-learning integration was categorized. As mentioned, we collected all potential articles and then examined them individually for any focus relevant to the digital transformation. Figure 1 illustrates the detailed flow diagram of the systematic review for the article search. The flow diagram showed that 729 articles were derived from the initial search. The 729 articles were further screened to identify duplicates and irrelevant articles, leaving 134 articles relevant to digital transformation. Another screening was carried out on the 134 articles, and 71 articles matched the exclusion and inclusion criteria about digital transformation. Nevertheless, we just examined 42 articles because some of them were due to the 27 articles were incorporated in higher education and preschool, and another two articles were incorporated between primary and secondary education synthesis.

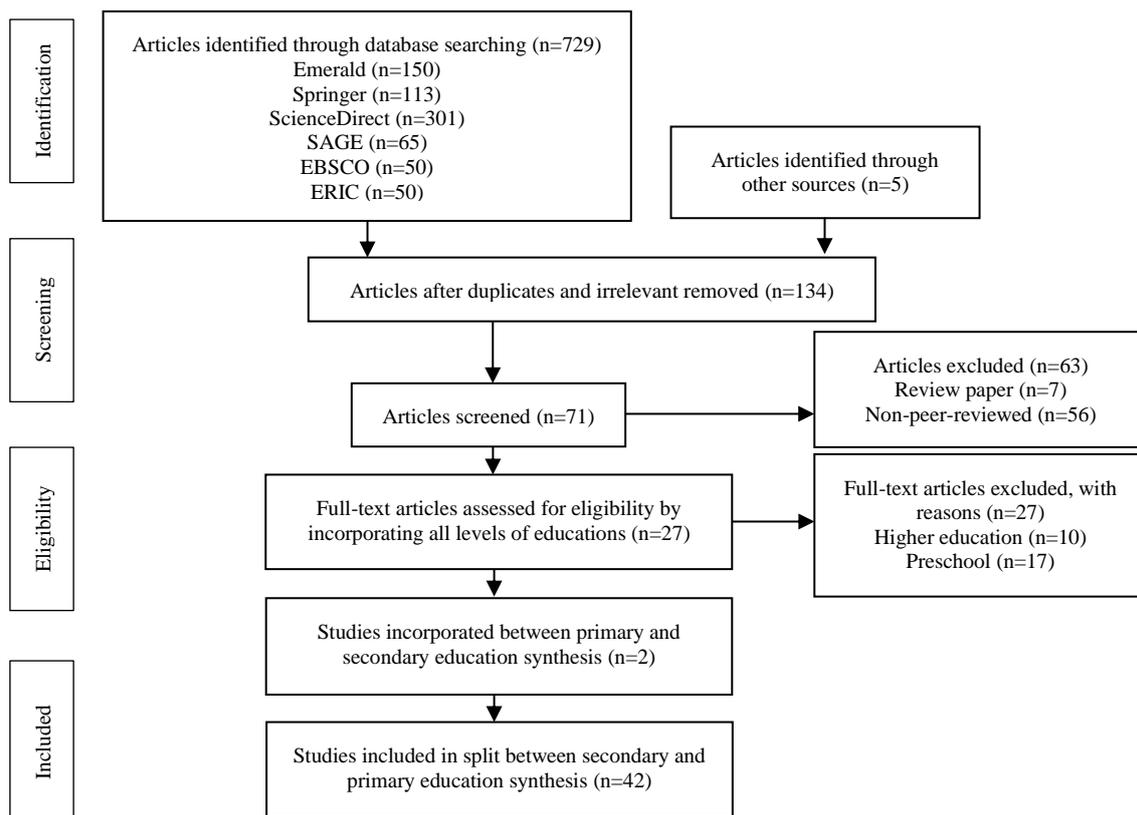


Figure 1. Systematic review flow diagram of the articles search

3.3. Data analysis

The analysis was conducted concurrently with data collection as the process of data collection, data analysis, and report authoring are all interrelated and occur at the same time [21]. Selected articles were retrieved from Scopus databases on 5 May 2022, and the data required for the systematic literature review

were obtained and extracted. The NVIVO version 12 software, Microsoft Excel, and Coggle were used to organize, analyze, and visualize the selected empirical results articles. The content analysis, constant comparative technique, and grounded theory [22] were employed to inductively construct the themes during the coding procedure for answering two research questions.

During ‘Open coding’, the data from the transcript were read and analyzed line by line to look for similarities and differences for each selected article. We put together the codes we thought were similar and repeated the analysis process for all the data in the research article. The codes that three different researchers coded to ensure the validity of the theme that emerged [21]. We realized that similar words and phrases were used in different research articles dealing with similar ideas. This recurring pattern of ideas became a theme. We could navigate through the phrases, quotes, codes, and memos in the NVIVO version 12 software's node unit. During this grounded theory procedure, we analyze the data to uncover the entire article. It is hoped that the analysis can also explain not just the drawbacks and challenges of the phenomena but for the strategies implemented by the schools’ stakeholders to resolve the issue to successful e-learning implementation in schools.

4. RESULTS AND DISCUSSION

This literature review discusses the implementation of digital transformation, in particular the successful e-learning integration among teachers in public schools. According to the inclusion and exclusion criteria, we obtained 42 articles from various journals between 2010 and the current year (2022) to ascertain that we have recorded the latest situation of e-learning implementation among teachers in public schools. The systematic review uncovered 57.1% (n=24) of the published articles in developing economies such as Malaysia, Morocco, and Rwanda as seen in Table 2. These studies uncovered 42.9% (n=18) of the articles for developed economies, such as Portugal, Australia, and Switzerland. Within the given time range (from 2010 to 2021), there was a significant fluctuation increase in the number of articles: 2010 (n=4), 2011 (n=2), 2012 (n=3), 2013 (n=2), 2015 (n=5), 2016 (n=4), 2017 (n=1), 2018 (n=2), 2019 (n=5), 2020 (n=6), and 2021 (n=6). This fluctuation of articles published suggests that digital transformation has an important role in the education of public schools, especially during the COVID-19 pandemic.

The systematic review also uncovered that 35.7% (n=15) of the published articles in secondary schools, compared to primary schools, is 64.3% (n=27) articles. The differences can be reflected that primary schools are not deniable to receive better digital transformation in education as many years, secondary schools have been the focus of the researchers due to various teaching strategies utilizing digital tools in the teaching of different subjects [23], [24]. Most research employed quantitative research, namely survey (n=19, 45.2%), followed by qualitative research, such as interview, observation, and focus group discussion (n=12, 28.6%). Mixed-method methodology also adopted by researchers (n=11, 26.2%). Finally, using a constant comparative technique approach to the analysis, ten themes emerged to answer the first research question. There were four prominent digital transformation theories derived from answering the second research question as shown in Figure 2.

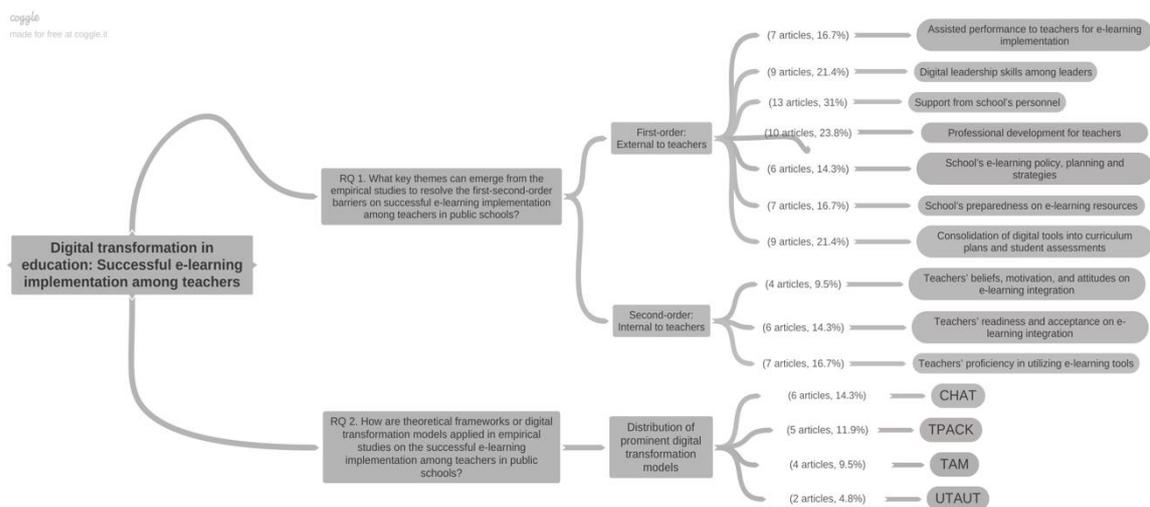


Figure 2. Detailed organization of findings

Table 2. Systematic review results for digital transformation among teachers (2010-2022)

No.	Ref.	(N), Location, Education level, Types of economies	Theoretical framework	Methods	Contain themes									
					External to teachers					Internal to teachers				
					AP	DL	SS	PD	PS	SP	CS	BA	RA	PE
1	[25]	(650T), Jordan, Secondary, Developing	DOI [26]	Survey								8		
2	[23]	(365S), Malaysia, Secondary, Developing	Educational Change [27]	Survey; FGD; Observations								8		
3	[24]	(3T, 3H, 3R, 3S), Singapore, Secondary, Developed	CHAT [28]	Observations; Interviews, FGD; Documents review		2	3		5		7			
4	[29]	(7R; 7C; 25T; 388S), Australia, Primary, Developed	Learning Outcomes Pedagogy Attributes	Interview; Observation; Survey; Document analysis					5					
5	[30]	(820T), China, Primary, Developing	Constructivist belief framework [31]	Survey			3	4	5			8		
6	[32]	(10T; 59T), Norway, Secondary, Developed	-	FGD; Survey					4					
7	[19]	(12T), The U.S., Primary, Developed	First-second- order barriers	Interview								8		
8	[33]	(133T; 347T;), Korea, Primary, Developed	21st-century learning environments	Survey										10
9	[34]	(48T), Australia, Primary Developed	Digital age learning matrix [35]	Survey; Interview; Document analysis	1									
10	[36]	(119T; 60T), Ireland, Primary, Developed	Digital Natives Theory [37]	Survey; Interview				4						
11	[38]	(11T), Cyprus, Primary, Developed	CHAT [39]	Survey; Interviews; Observation	1									
12	[40]	(874T), Indonesia, Secondary, Developing	-	Survey								8	9	
13	[41]	(7T; 28S), Singapore, Primary, Developed	Learning from and with ICT	Interview; Survey to students		2	3				7			10
14	[42]	(4T; 128S), Cyprus, Primary, Developed	CHAT [39]	Interviews; Observations; Book engagement FGD	1									
15	[43]	(23T), Canada, Primary, Developed	-	FGD		2	3	4		6	7			
16	[44]	(376T), Ghana, Secondary, Developing	Beliefs	Survey				4						
17	[45]	(4T), Iran, Secondary, Developing	-	Interview; Field notes			3						9	
18	[46]	Canada, Primary, Developed	CHAT [39]	Interviews; Reflections; Observations	1									
19	[47]	(34T; R; C), Singapore, Primary, Developed	CHAT [39]	Observations		2								
20	[48]	(56T; 4T), Morocco, Secondary, Developing	TAM	Survey; Interviews	1									
21	[49]	(30T), Rwanda, Primary, Developing	TPACK [50]	Survey										10
22	[51]	(217T), South Africa, Primary, Developing	Computer self- efficacy theory	Survey		2				6		8		

Table 2. Systematic review results for digital transformation among teachers (2010-2022) (*continued*)

No.	Ref.	(N), Location, Education level, Types of economies	Theoretical framework	Methods	Contain themes									
					External to teachers					Internal to teachers				
					AP	DL	SS	PD	PS	SP	CS	BA	RA	PE
23	[52]	(2T), Australia, Primary, Developed	TPACK [50]; SAMR model [53]	Interview; Observation			3							10
24	[5]	(616T), Indonesia, Primary, Developing	Motivational beliefs	Survey						6		8		
25	[54]	(148T), Nigeria, Secondary, Developing	TPACK [50]; SITES	Survey										10
26	[55]	(8T; 2R; 2H; 2C), Malaysia, Primary, Developing	Sociocultural, Perspectives [56]	Interviews; Document analysis	1	2	3							
27	[57]	(1987T), Mongolia, Primary, Developing	Professional Competency	Survey		2		4	5		7			
28	[58]	(156T), Hong Kong, Primary, Developed	TAM	Survey			3	4	5					
29	[59]	(2T), Indonesia, Primary, Developing	TPACK	Observation; interview				4						10
30	[3]	(180T), Iran, Secondary, Developing	-	Survey						6				10
31	[60]	(102T), Zambia, Secondary, Developing	Activity Theory [61]	Survey	1		3			6				
32	[62]	(155T; 25T), Mauritius, Secondary, Developing	TAM UTAUT	Survey; FGD			3				7			
33	[63]	(1T; 5S), Sweden, Primary, Developed	Didactic	Observation; Interview; Document analysis Survey				4			7			
34	[64]	(207T; 276S), Palestine, Primary, Developing	-	Survey				4		6	7			
35	[1]	(4T; 1R; 1H; 1C), Malaysia, Primary, Developing	CHAT [39]	Interview; Observation; Document Analysis Survey			3		5	6		8		
36	[65]	(90T), Portugal, Secondary, Developed	UTAUT	Survey										9
37	[66]	(60T), Malaysia, Primary, Developing	TAM	Survey										9
38	[7]	(89T; 96S), Turkey, Primary, Developing	-	Interview; Survey			2							
39	[67]	(400T), Malaysia, Secondary, Developing	Transformational leadership styles	Survey			2							
40	[10]	(356R), Turkey, Primary, Developing	-	Survey			3							
41	[68]	(1692T), Switzerland, Secondary, Developed	Will Skill Tool Pedagogy model [69]; TPACK [70]	Survey			3				7			
42	[71]	(162T), Ukraine, Primary, Developing	Formative assessment	Survey							7			

Note: N=Sample size; T=Teachers; H=heads of curriculum department; S=Students; R=Principals or Headmasters; C=ICT Coordinators; FGD=Focus group discussion. AP=Assisted performance; DL=Digital leadership skills; SS=Support from school's personnel; PD=Professional development; PS=Policy, planning & strategies; SP=School's preparedness; CS=Curriculum plans & student assessments; BA=Belief, motivation, and attitudes; RA=Readiness & acceptance; PE=Proficiency in utilizing e-learning tools

4.1. Antecedents of successful e-learning implementation among teachers

Most research conducted in both developed and developing countries has found a few precursors that encourage public school teachers to integrate e-learning to implement it successfully. This successful implementation of e-learning takes place when these antecedents are fulfilled. Otherwise, as an external (first-order) or internal (second-order) barrier, the entire process is hindered [19], [20]. However, once external antecedents to teachers were fulfilled, internal antecedents to teachers also were achieved.

Based on the first research question of the systematic review, themes that emerged comprise 10 concepts (external and internal to teachers): i) Assisted performance to teachers for e-learning integration; ii) Digital leadership skills among leaders; iii) Support from school's personnel; iv) Professional development for teachers; v) School's e-learning policy, planning, and strategies; vi) School's preparedness on e-learning resources; and vii) Consolidation of digital tools into curriculum plans and student assessments; viii) Teachers' beliefs, motivation and attitudes toward e-learning integration; ix) Teachers' readiness and acceptance of e-learning integration; and x) Teachers' proficiency in utilizing e-learning tools. Figure 3 indicates 10 concepts of first-second-order barriers to successful e-learning implementation among public school teachers.

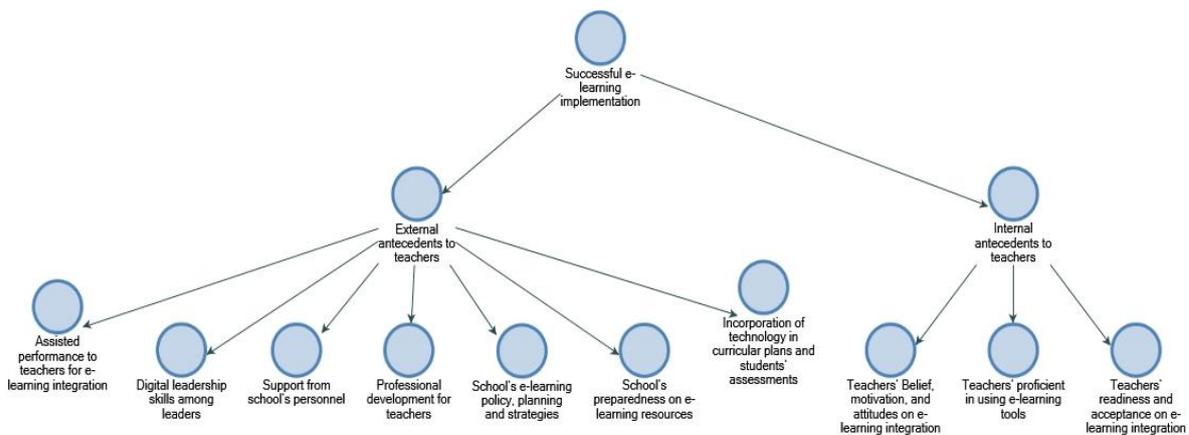


Figure 3. Framework of successful e-learning implementation among public school teachers

4.1.1. External antecedents to teachers for successful e-learning implementation

a. Assisted performance of teachers for e-learning integration

Assisted performance is one of the mechanisms that encourage teachers' e-learning integration. Tharp and Gallimore [72] defined assisted performance as "what a novice can do with help, with the support of the environment, or others, and of the self." They developed the concept of assisted performance from Vygotsky's sociocultural perspectives, including two key components of Vygotsky's central component for effective teaching. The zone of proximal development (ZPD): a novice performance with assistance from an expert and a more proficient colleague. Thus, the actual definition was that expert guidance enhances beginner performance. Nevertheless, supported performances can also be defined as a personnel effort to support schools, especially teachers, for the students' benefit [55]. In this sense, teachers are willing to integrate e-learning when assistance is provided or when teachers' performance necessitates assistance in a variety of forms.

A study in Malaysia revealed that assisted performance is not merely from IT-savvy professionals, technicians, managers, and colleagues that are willing to motivate each other. It also comes from non-experts, as long as they voluntarily support their schools in any way, including charities, providing manpower and resources. One aspect of assisted performance is the participation of a school community. The school's community may include alumni from the school board, members of the Parent-Teacher Association (PTA), technology developers, and local business owners [55].

The schools foster sharing of ideas among teachers as one of the assisted performance aspects that encourage teachers' e-learning integration. One study in developed countries such as America proposed the importance of peer support, affirming collaboration, and knowledge sharing as factors that led to successful e-learning implementation by teachers [42]. Another empirical study found that sharing ideas among school stakeholders is essential for reducing teachers' workload. For instance, previous researchers [46], [60] stated that to tackle teachers' workload, sharing sessions need to be held to create e-learning-based lessons. Current

research in South Africa and Iran are in agreement with these study's results that information exchange and mutual trust among teachers are among the main reasons for teachers' motivation to integrate e-learning [59].

b. Digital leadership skills for the leader among leaders

Empirical evidence on teachers' e-learning points out the vital role of a school's digital leadership in encouraging and implementing e-learning [43], [55], [57]. Previous research in a developed country found that teachers regard school principals' leadership as amongst the most essential motivators for utilizing e-learning tools [43]. Another study from developing countries like Mongolia found the crucial role of school leaders in proficiency in digital skills for encouraging teachers to integrate e-learning [57]. According to one quantitative survey conducted at a Johannesburg primary school in South Africa, headmasters are viewed as the facilitators and motivators of e-learning integration [51]. Furthermore, one qualitative approach in English Quebec Schools recommended that school leaders establish clear plans and goals for e-learning integration. United Nations Educational, Scientific and Cultural Organization (UNESCO) also reported on this point of view in e-learning integration [73].

School leaders need to employ a particular leadership style for a successful e-learning integration. As a result, styles of leadership have received considerable attention. Previous research in developed countries suggests that to assure the success of any activity, school leaders, particularly those involved in e-learning integration, should employ a distributed leadership model [24]. Distributed leadership refers to the aspect that will guide a headmaster to manage the expectations by shared decision-making with other schools' leaders, such as the head of the instructional program and the coordinator of e-learning [55]. It also proposes that leadership can be distributed in various ways to encourage collaboration at times and in parallel with others to achieve the best possible outcomes, so-called "the leader among leaders." In this sense, everyone could be a leader and is responsible to distribute or transfer the information. Eventually, all stakeholders are able to implement the school's vision as the information reaches out. As a result, a number of leaders, including the principal or headmaster, and any teachers who are responsible as leaders, can take on the duty of improving the schools to a higher level [47], [67]. Another study in developed countries, such as Singapore, discovered that the effectiveness of e-learning integration in schools is based not only on the headmaster but also on the engagement of all school leaders [74].

Critical for a leader to be capable of planning and organizing digital leadership initiatives. This capability can assist schools in enhancing their students' grades [7], [67]. School principals should assist in creating a digital learning culture in schools such as encouraging teachers to be cooperative and innovative in teaching methods, providing the information about digital transformation, follow-up, and financial support, so that the teacher can see the importance to implement digital transformation and attend the courses of technology-based professional development in schools [67]. Another study [7] mentioned three types of skillset leaders develop are: i) Technological knowledge; ii) Administrative abilities; and iii) Personal abilities. There were seven objectives of digital technologies for leaders to transform their conventional method to lead their organization, namely: i) Employee communication; ii) School news and announcements; iii) Document sharing; iv) Student-parent communication; v) Social media promotion; vi) Management process information; and vii) Online meetings with stakeholders.

c. Support from school's personnel

There has been a substantial amount of literature published on teachers' e-learning integration [30], [43], [45], [55], [62], [75]. The literature indicates that school personnel support would contribute to successful e-learning implementations. The school's personnel include members of the technical team, the administrative team, and colleagues. One study in Mauritius employed a quantitative approach on 155 Mathematics teachers. It found that 90% of teachers perceived personnel support, especially technicians, as significant antecedents that facilitated their willingness to integrate e-learning [52], [62].

Another recent study asserted that providing administrators and e-learning coordinators with adequate assistance will boost educators' commitment to utilize digital tools [58], [75]. Previous researchers advised that this type of continuous support for teachers will increase their confidence in integrating e-learning. This viewpoint is consistent with previous research [60], which claimed that the support of the e-learning coordinator and the school administrator is required to ensure that e-learning integration activities achieve the desired outcome. Rabah [43] considered school principal leadership as one of the most important factors in the successful adoption of e-learning. The researcher also argued that having school leaders' support and a clear e-learning vision, as well as making expenditures in e-learning integration, such as e-learning training, are worthwhile.

According to the literature, all schools need technical support to solve technical problems related to e-learning integration. Previous research has found that a lack of technical support specialists to troubleshoot technical issues has been a barrier to teachers integrating e-learning. For example, one study in urban and rural schools in Australia manifested that a non-extensive level of technical support has become the schools'

issue in attaining the success of e-learning integration [52]. Thus, scholars suggested that leaders have a clear goal of supplying technical personnel to expedite e-learning integration implementation [1], [43], [60]. Another prominent scholar on e-learning in public schools asserted that teachers could effectively prevent their students from engaging in delinquent behavior that may be the result of technical assistants' lack of supporting role [60]. A technical support team can be constituted in the event of technical difficulties [75]. This group will address any technological concerns that emerge before, during, or after a class that uses e-learning [24].

Previous research has stressed the importance of peer support in successful teachers' e-learning implementation. Razak *et al.* [1] claimed that teachers would be distracted or burdened by administrative duties. Some scholars have suggested reducing teacher responsibilities, such as clerical work [60], [68]. Scholars suggested that providing peer support, collaboration, and knowledge-sharing are three ways to reduce teacher workload [60]. One study in Singapore, for example, argued that teachers must undertake sharing sessions to plan and build e-learning-based lessons to reduce teacher strain [74]. In one study of secondary schools in Iran, information sharing and collaboration among teachers were also significant antecedents that encouraged teachers' enthusiasm to integrate e-learning into their teaching [45].

d. Professional development for teachers

For 10 years, e-learning teacher training has been at the heart of the teaching profession. The growth of comprehensive and high-quality teachers is the most critical professional development criterion [24]. According to recent study [57], quality training is a significant concern that can boost teachers' confidence in exploring digital tools integrated into a curriculum. Other current studies in high-income economies like Sweden and Hong Kong argued that continuous e-learning training is more effective because it influences teachers' abilities and confidence in e-learning integration [58], [63]. Each e-learning training might provide teachers with the necessary information and abilities [43]. After completing the training, teachers started to ponder how computers could be utilized to enhance T&L. This is based on a quantitative longitudinal study of teachers [36]. Another mixed-method research that was carried out in Norway found that teachers had "strong beliefs" in the use of e-learning after two years of training [32].

Previous studies conducted over a decade in third-world nations revealed that the majority of teachers trained in the integration of e-learning were highly limited [44], [59], [64]. Furthermore, the e-learning training provided by the Ministry of Education's State Education Department or other outside organizations does not meet teachers' career and professional development needs [64]. Pre-service teachers should be provided with high-quality e-learning training as this will acclimate them to e-learning-integration contexts once they graduate. This perspective is supported previous study [30], which carried out a quantitative study in primary schools in China and discovered that high-quality e-learning training improved e-learning integration.

E-learning training programs need to address teachers' needs for professional development, not just knowledge and technology. According to several researchers, pedagogical training [43], leadership training [64], knowledge transfer training (to educate young teachers to value the participation and opportunity to discuss with colleagues) [36], and students' assessment coaching for assessing e-learning-related outputs, as well as teacher's new role as a facilitator or coach (more training in e-learning skills, such as problem-based to teach e-learning to students in an active learning and collaborative learning environment) are all that is needed among teachers [63]. A recent ethnographic study by Kjellsdotter [63] focused on teachers and students to understand e-learning integration at Bezel Primary School in southern Sweden with respect to the teachers' selection of educational content related to e-learning integration in public schools.

Various training courses increase the level of e-learning integration by teachers. This is because such training improves the ability of teachers to use e-learning. These trainings are part of a professional development plan that enhances e-learning integration into activities of training programs. The school-based training should emphasize hands-on experiences and involve teachers as trainers within a sufficient time [63].

e. School's e-learning policy, planning, and strategies

There is an emerging body of literature on school e-learning policies, plans, and strategies for e-learning integration by teachers. The formation of the policy and plan would aid the realization of the desired outcomes among teachers [30]. Prominent e-learning scholars [24] have indicated that a technology policy plan is a significant factor influencing teachers' use of technology in schools. Anderson [76] provided the first definition of technology policy planning in the 1990s, asserting that technology policy planning entails the development, implementation, and revision of technology plans to guide organizations in achieving their goals. The term "technology policy plan" refers to a school's explanation of its goals, materials, activities, and aspirations regarding the integration of e-learning [29]. The school technology policy should incorporate technologies into the classroom, autonomy for teachers to innovate in pedagogies,

professional recognition, and the availability of resources. This policy can be implemented in the school with the assistance of e-learning coordinators [57], [58].

E-learning plans must not prevent teachers from saving and spending money. This position is in agreement with Mulenga and Marbán [60], who argued that technical plans need to be implemented before transferring financial resources by the school to determine the efficient use of funds. In other words, where and in which the money is used must be determined. Mulenga and Marbán urge that to attain such a vision, a thorough examination of the existing crisis is required, including identifying flaws in the implementation of e-learning in classrooms and developing strategies for attempting to solve difficulties related to inefficient e-learning planning. Qaddumi, Bartram, and Qashmar [64] found conflicts over IT policies at the school level as teachers are not accounted as a vital contributor to constructing a school's e-learning policy. Another precursor is that school policymakers do not refer to teachers, particularly regarding computer placement in the classroom and whether IT staff need to link students' desks with mobile technology.

School policies represent school culture as the success of e-learning integration depends on the actions of the schools' stakeholders to obtain the schools' vision set out in the school policies [1]. Maslowski [77] defined a school culture as "the basic assumptions, norms and values, and cultural artifacts that are shared by school members." According to a qualitative case study of secondary schools in Singapore, the schools have established a culture that allows them to function as responsive learning organizations, particularly in the swift rise driven by the integration of technology into the curriculum [24]. Teachers, educational programs, and e-learning coordinators should have curriculum-based e-learning for learning organizations to succeed [24]. Regulations need to be established in school culture, which can be imitated by other schools.

f. School's preparedness on e-learning resources

Western and Asian scholars have found that school readiness for e-learning resources, such as hardware, connectivity, and software is one of the most essential prerequisites for a successful implementation of e-learning in schools [1], [60]. For example, e-learning integration failure in Western schools can be attributed to a number of factors, namely: i) The availability of e-learning facilities in a limited number of classrooms; ii) The availability of only a few computer labs for e-learning-integrated lessons to be held in each school; iii) Frequent technical problems with computer networks; and iv) Slow internet connection speed [1], [43]. A quantitative study conducted in Asian public secondary schools, such as those in Iran, discovered that outdated technological resources and a lack of e-learning facilities contributed to the failure of e-learning integration [3]. Esfijani and Zamani additionally discovered that software access in public schools is not at a satisfactory level. These studies suggested that a school's readiness to offer e-learning resources is a crucial issue in achieving e-learning integration in public schools.

E-learning resource readiness refers to the school's budget provision for e-learning resources. Numerous empirical studies in developed and developing countries have highlighted the importance of funding e-learning resources to provide the fundamental infrastructure of e-learning amenities [1], [43], [51], [52]. In a qualitative study done in Canada, Rabah [43] found that funds were concentrated on buying new equipment and software. However, certain classrooms were not suitable for e-learning at the time of construction. Similar results in South Africa and Malaysia, several studies found that lack of budget allocation yielded inconsistent specific e-learning training [1], lack of specific e-learning software [5], and teachers' e-learning self-efficacy [51]. One qualitative study in urban and rural schools manifested that content-specific digital tasks that are transformative rather than enhancement-level should be initiated to teachers [52].

g. Consolidation of digital tools into curriculum plans and student assessments

After 10 years, the relationship between the success of e-learning implementation and the integration of digital tools into the curriculum was identified. Schools require curriculum-directed e-learning to provide teachers with a clear goal for integrating e-learning [24], [68]. To better understand how teachers in Singapore dealt with various types of e-learning integration, Divaharan and Lim focused on three types of secondary schools. The application of digital tools in curriculum planning is in support of [74] argument that the curriculum restricts student learning planning and organization. Tay and Lim also carried out two case studies at chosen primary schools in Singapore. Aside from observations, these included in-depth teacher interviews and focus group discussions with students. The findings were consistent with those of another recent study conducted in a developing country such as Mauritius [62]. Perienen carried out a quantitative survey of 155 Mauritius teachers and found that 87% of them wished that schools would use an inflexible timetable curriculum to obtain e-learning-related performance from their students. Contrary to a study in Hong Kong and Switzerland, teacher training institution management had little involvement in integrating e-learning into the curriculum [58], [68].

The impacts of European policies on the Swedish curriculum have contributed to ideas about managing school information regarding competencies [63]. In 2017, Swedish curricula were revised to improve students' digital competencies. The guidelines recommend the use of e-learning without clearly pointing out how to integrate e-learning into the subject. This is because digital abilities are not to be evaluated and are therefore not a criterion to be achieved but an ability to achieve results in a subject. The results suggested that teachers are motivated to take advantage of their freedom of education to run classrooms for e-learning as a transformation in public schools. Teachers also search for organizational forms of education according to unclear curriculum guidelines for how e-learning is integrated with regard to subjects. Apart from that, teachers should be given autonomy to innovate their pedagogies [63].

International studies have identified a link between student assessment integration and e-learning practices in Western or developed countries, showing that student assessment has hindered teacher e-learning integration. A qualitative study of Quebec English Schools in Canada included detailed interviews with 23 teachers and school counselors who saw the importance of re-analyzing assessment methods when integrating e-learning into educational programs by examining how e-learning can meet student assessment requirements [43]. Rabah further argued that it is difficult for teachers to incorporate e-learning because they do not know how to measure it when assessing students' e-learning-related outcomes. Prominent e-learning integration, Kjellsdotter [63] and UNESCO report [73] have argued that e-learning assessment is unnecessary because students are evaluated through examinations. Formative assessment, on the other hand, is required for identifying learners' needs, tracking each student's progress, and triggering their motivation to learn. Zhorova also urged school administrators to create a manual for teachers on how to use digital tools for formative assessment [71].

4.1.2. Internal antecedents to teachers for successful e-learning implementation

a. Teachers' Beliefs, motivation, and attitudes toward e-learning implementation

Teachers' beliefs in e-learning integration can improve student learning, resulting in facilitating e-learning integration among teachers [5], [38]. According to Calderhead, beliefs are "suppositions, commitments, and ideologies" while knowledge is "factual propositions and understandings" [78]. For instance, a study at Australian primary schools found that teachers' beliefs about e-learning resulted in the best way to do it. The goal was reached when teachers acknowledged the e-learning role as an instrument to build knowledge via collaborative activities, the relevance of e-learning to society & future employability, and the emphasis on genuine problem-based approaches in T&L [78].

A different qualitative case study of teachers in the United States' primary and junior high schools found that their beliefs about integrating e-learning could transform their teaching from teacher-centered to student-centric [19]. The authenticity, student choice, and collaboration that students are able to achieve through teacher-integrated e-learning are known as student-centric learning [19]. A quantitative study by [30] found that teachers' beliefs about e-learning help students comprehend their learning. Other studies in developing countries, including Malaysia, have found that the top levels of teacher beliefs can lead to the top levels of teachers' e-learning implementation [5], [25], [40], [67].

Teachers' motivation to integrate e-learning may increase if they believe it will benefit their students' learning [1], [5], [30], [34]. Motivation is the process of initiating and maintaining goal-directed behavior [79]. Another way of saying it, motivational factors are considered part of a teacher's goal structures and beliefs regarding what is essential and valuable for student learning [80]. Other researchers have highlighted the benefits of e-learning in facilitating and improving the educational processes, including the use of technological instruments in demonstrating, drilling, and practicing exercises, modeling, representing complicated knowledge aspects, discussing, collaborating, and conducting project work [30]. In a quantitative study by several researchers [30], they sought to unveil constructivist beliefs among Chinese primary school teachers, stating that teacher motivation has a direct influence on e-learning integration into the classroom [30]. The researchers also found that teachers became interested in integrating e-learning when the schools were well-equipped with e-learning infrastructure and offered appropriate support from the technical and management teams [5].

The empirical research on e-learning integration implemented over the last decade seemed to focus on attitude as one of the precursors to teachers' successful e-learning adoption. The results showed that teachers were keen on integrating e-learning when they exhibited a positive attitude. Attitude, according to Fishbein and Ajzen [81], is a "learned predisposition to respond in a consistently favorable and unfavorable manner with respect to a given object." Without a positive attitude, developing e-learning skills among teachers is difficult. Attracting teachers to practice innovative pedagogical approaches that are preconditions for effective integration of e-learning in public schools is almost impossible [48], [51].

Dube, Nhamo, and Magonde [51] also argued that teachers' attitudes in relation to e-learning integration should be a key factor in motivating them to do so. This point of view is in line with [19], who claimed, as a Western academician, that the greatest obstacle to teachers integrating e-learning was their pre-existing mindset regarding the integration of e-learning. This factor was found to have the most influence on teachers' achievement in e-learning integration. This point of view is shared by [25], who carried out a quantitative study in Jordan and found that teachers who possessed positive attitudes toward e-learning implementation and teachers' level of e-learning integration were significantly associated with their attitudes towards e-learning.

b. Teachers' readiness and acceptance of e-learning integration

Teachers' readiness is one of the aspects that need to be considered for a successful e-learning implementation. Numerous studies revealed that individual readiness is connected to their levels of knowledge, information, and experience in relation to the types of digital tools they would implement in e-learning [40]. This viewpoint is consistent with [45], who discovered that appropriate information, as well as sufficient resources, improved teachers' readiness to integrate e-learning into the classroom [45]. On the contrary, teacher self-motivation is one of the factors that indicate teachers are prepared for activities and innovations, as revealed by Copriady [40]. Besides, motivation is an important indicator between the variables of preparedness and technological instruments in T&L. Copriady carried out a quantitative survey on 874 secondary school teachers in Indonesia. The sample size was 446 science teachers and 428 social science teachers. Because all aspects are linked to teachers, they are ready to adapt and adjust based on the organization's goals.

Teachers should be knowledgeable of digital tools to be ready and eventually accept the value of integrating e-learning with their students. Diverse models can be employed to measure an individual's acceptance of adopting innovation, such as Theory of Reasoned Action (TRA) [82], as well as Theory of Planned Behavior (TPB) [83], [84]. However, based on the search strategy for the purpose of this systematic review, we found only two models, namely the Technology Acceptance Model (TAM) [85] and the Unified Theory of Acceptance and Use of Technology (UTAUT) [86]. Davis [85] proposed TAM with the fundamentals of salient beliefs: from perceived usefulness (PU) to perceived ease of use (PEOU).

Omar and Hashim [66] conducted a survey by employing TAM for e-learning to measure professional development among Malaysian English Teachers. Omar and Hashim revealed that teachers perceived PU based on the belief that utilizing a specific learning approach and digital tools, in particular e-learning, would raise teaching performance. Besides that, PEOU as teachers searched for digital tools that would lessen their effort in teaching. On the other hand, Veiga and Andrade [65] employed the Unified Theory of Acceptance and Use of Technology (UTAUT) to measure teachers' acceptance in various subjects, including Languages, Mathematics & Informatics, Experimental Sciences, Human & Social Sciences, and Expressions. According to the findings of this quantitative study, attitude is the most important factor in influencing teacher acceptance of e-learning as a teaching tool [65]. Therefore, if teachers felt that digital tools are useful and easy to use, they would implement e-learning.

c. Teachers' proficiency in utilizing e-learning tools

Teachers' proficiency in utilizing e-learning tools is required, and they must meet the needs of their students for effective e-learning integration. On the contrary, if teachers do not have the essential skills or cannot integrate e-learning into their lessons, this leads to failed e-learning integration [3], [71]. For example, studies in developed and developing countries discovered that numerous tools are utilized, such as iPads, Digital Cameras, Netbooks, a TuxMath game, Interactive White Board, and laptops, but teachers were not skillful in the utilization of these tools for teaching mathematics which led to the failure of digital investment in public schools [52].

A study carried out in Korea to understand teachers' digital skills for the 21st-century learning environments, namely: i) Learning Scratch for computational and creative thinking; ii) Learning robotics as an emerging technology for convergent and divergent thinking; and iii) Learning by design with ICT for systems thinking. Teachers must examine new roles in the e-learning integration, particularly new media literacy skills and adaptive know-how with efficiency and innovation in knowledge transfer [33]. This point of view advocates for teachers to have a diverse set of skills, including technical and communication abilities. Learning Scratch for computational and creative thinking, as well as robotics as a new technology for convergent and divergent thinking, will help develop these skills. Teachers also need to possess technical knowledge and skills in dealing with instructional videos, simulation, data management, database use, mind-mapping, discovery learning, brainstorming, digital storytelling, and the internet [41].

Teachers should be proficient and knowledgeable in technological, pedagogical, and content aspects in utilizing e-learning tools within the curriculum. These aspects can be better understood by underpinning the Technological, Pedagogical, Content, and Knowledge (TPACK) framework [50]. Teachers will be able to

use e-learning tools once they understand how these three knowledge domains are interconnected and how they interact with one another within the curriculum [52]. One quantitative study conducted in Australia on e-learning tools, such as the TuxMath game, discovered how teachers utilize digital tools in the classroom relates to their TPACK developmental stage [52]. Various recent studies in Western [66] and Asian countries [59] refer to TPACK for understanding digital technologies within curriculum implementation among public school teachers. For example, one of the developing countries, Rwanda, conducted one study on teachers' perceptions of integrating e-learning through the implementation of One Laptop Per Child (OLPC) into their teaching [49]. The researchers discovered that implementing the OLPC program necessitates teachers to learn TPACK skills. Another recent study conducted in developing countries, such as Nigeria [54], underpinned TPACK to study teachers' practice on e-learning integration. These recent empirical studies indicate TPACK as crucial in investigating e-learning practice within the curriculum among teachers.

d. Digital transformation models for successful e-learning implementation among teachers

A review of literature managed to facilitate the researchers in selecting relevant theories to explain the issues under study. Table 2 shows the theoretical frameworks that can be considered for future studies, namely: the School Improvement Perspectives, Constructivist Belief Framework, Digital Age Learning Matrix, Digital Native Theory, and Ecosystem Theory. Other than these theories, the Cultural-Historical Activity Theory (CHAT) was used to frame the analysis in previous studies [1], [24], [38], [42], [47]. The use of CHAT has been prominent for the past thirty decades, particularly with regard to sociocultural theory or sociohistorical theory [87] or activity theory [61].

Cultural-Historical Activity Theory has been considered appropriate to be incorporated with activity system analysis (ASA) in analyzing data such as those derived from the present study. CHAT is also appropriate to be employed with a case-study approach because the relationships derived between the activity system's components can facilitate understanding the entire activity in an organization [88]. Although CHAT has been widely used in studies in developed countries, the theory can be employed to understand similar phenomena in a developing country such as Malaysia. Based on Table 3, only one article [1] reported the use of CHAT as an analytic lens for a study in developing countries. This gap would prompt the use of CHAT in future studies to holistically understand teachers' e-learning integration into teaching in an existing public-school context.

There were five international studies on primary education focused on a sociocultural perspective towards understanding the process of integration of e-learning into teaching [1], [38], [42], [47]. Concluding from the sociocultural perspective, Luria [89] claimed that "man differs from animals in that he can make use of tools", and Vygotsky [56] claimed that "tool mediation" is human beings' use of "tools" to mediate their action within their social environments. These quotes were interpreted as the nature of individual action influenced by their environments with the "tools mediation" such as digital tools. Thus, the relationship between individuals and technology tools could be explained from a sociocultural perspective. As indicated in Table 3, many international studies have centered on sociocultural perspectives as an attempt to understand the individual action shaped by the social environment in which the technologies are situated. This shortcoming points to the need for similar research to be conducted in developing countries, especially in Malaysia's secondary settings.

Cultural-Historical Activity Theory is used as a descriptive tool for explaining components and human activity interrelationships in activity systems. However, as Engestrom emphasizes in his explanation of cultural diversity issues, CHAT is an application of activity system analysis in developmental research. Engestrom went on to create conceptual tools for "understanding dialogue, multiple perspectives, and networks of interacting activity systems" [39], [90].

As shown in Figure 4, Engestrom expanded the unit of analysis from one to two or more interconnected activity systems [91], [92]. According to Engestrom [39], the activity's object is a moving target that cannot be reduced to conscious short-term goals. Hence, the establishment of joint and collective work between various participants who are administered by rules and divisions of labor in the determination of the new objects of interrelating activity systems.

Cultural-Historical Activity Theory has aided researchers in analyzing "historical relationships among multiple activities by identifying how the results from a past activity affect new activities" [88]. CHAT can also be used with ASA to explain a school's cultural diversity. For example, Razak *et al.* [93] discovered that school stakeholders collaborated to resolve tensions caused by "contradictions" in different activity systems, which shaped the school's ICT culture and allowed for successful ICT integration in schools.

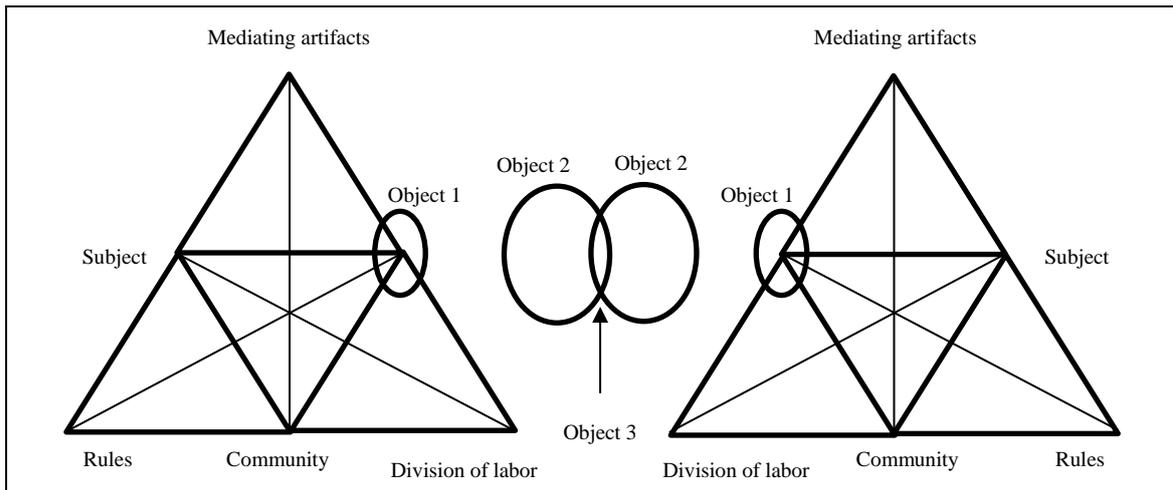


Figure 4. Two interacting activity systems as a minimal model [39]

As can be seen in Table 3, instead of CHAT, there are three prominent theories that researchers use to investigate digital transformation. First, TPACK [49], [52], [54], [59], [68]; Amelia *et al.* [59] urged high-quality e-learning to teach various skills and identify appropriate pedagogies, technologies, and teaching materials that represent teachers' TPACK in their teaching practice. TPACK has also been explained in the subsection “teachers’ proficiency in utilizing e-learning tools.” Second is TAM [48], [58], [62], [66]. Third, UTAUT [62], [65].

Technology Acceptance Model [85] and UTAUT [86] are the models that have been widely used in investigating teachers’ acceptance of e-learning implementation. However, TRA [82] and TPB [83], [84] are not well-explored in e-learning as both theories are widely used to measure individual acceptance of adopting innovation. Therefore, an individual’s acceptance and intention toward digital transformation require further investigation using TPB [83], [84].

Table 3. Distribution of prominent digital transformation models from the selected articles

	Theoretical framework	Ref.	Countries	Types of economies		Levels of education	
				Developed	Developing	Primary	Secondary
1	CHAT [28]	[24]	Singapore	√			√
2	CHAT [39]	[38]	Cyprus	√		√	
3	CHAT [39]	[42]	Cyprus	√		√	
4	CHAT [39]	[46]	Canada	√		√	
5	CHAT [39]	[47]	Singapore	√		√	
6	CHAT [39]	[1]	Malaysia		√	√	
7	TPACK [50]	[49]	Rwanda		√	√	
8	TPACK [50]	[52]	Australia	√		√	
9	TPACK [50]	[54]	Nigeria		√		√
10	TPACK [50]	[59]	Indonesia		√	√	
11	TPACK [70]	[68]	Switzerland	√			√
12	TAM [86]	[48]	Morocco		√		√
13	TAM [86]	[58]	Hong Kong	√		√	
14	TAM [85]	[66]	Malaysia		√	√	
15	TAM [86]; UTAUT	[62]	Mauritius		√		√
16	UTAUT	[65]	Portugal	√			√

This systematic review discovered that the available literature covers a broad range of educational stakeholders’ perceptions and experiences on successful e-learning implementation in public schools, such as teachers, students, parents, and top management. Although there is an increasing trend of research on the teachers’ e-learning integration in public schools, there is no comprehensive clarification covering both internal and external factors of teachers to guide schools to manage digital utilization for successful e-learning implementation. In addition, the literature on e-learning integration is inconsistent, and the precursors which motivate teachers' e-learning integration must be included and examined systematically to identify key themes in building a conceptual framework for successful e-learning implementation among school teachers. These concepts can be reliable strategies to guide the schools’ policymakers in managing the

digital transformation investment in education. As a result, the significant contribution of this systematic literature review is the themes obtained and formed as a conceptual framework, which cover both the first-second-order notions introduced by previous researchers [19] on the antecedents that might encourage the integration of e-learning among teachers.

At the top management level, including headmasters, heads of units, and e-learning coordinators, they can reflect the schools' technology strategic plan, emphasizing personnel to encourage teachers and provide professional development. Schools' administrators must ensure that they are well-prepared for e-learning resources. Without enough e-learning resources, it would be impossible for teachers to implement e-learning successfully as people of the highest digital investment management, school principals, and e-learning coordinators need to account for teachers' needs and views to implement e-learning in schools successfully. Thus, it would assist the schools' policymakers in understanding what support they should plan for their teachers and key personnel for schools to succeed in e-learning integration.

According to the systematic review, the findings can guide researchers in tackling digital transformation problems in education. Future research of longitudinal studies is much needed, especially in quantitative and qualitative methodologies, to acquire more comprehensive findings. The selected papers focused on digital transformation in education, particularly successful e-learning integration among teachers in public schools. Therefore, a possible limitation of this paper is that we did not search for the reference list in the selected articles or utilize the referral technique to discover the related research on the teachers' e-learning integration directly, which other researchers should take into account for future studies.

This review is beneficial to the research community into successful e-learning integration among teachers. The results offer a clear history of e-learning practice among public school teachers. The findings can assist in shaping strategies for successful e-learning implementation of e-learning among teachers and strategies for school stakeholders to effectively manage digital utilization in public schools, particularly in developing countries.

5. CONCLUSION

This paper presents a systematic literature review on the implementation of digital transformation in education, particularly the successful e-learning integration from the Scopus databases. According to the inclusion and exclusion criteria, we obtained 42 articles from various journals between 2010 and the current year (2022) to ascertain that we have recorded the latest situation of e-learning implementation among teachers in public schools. Schools should resolve internal and external aspects in relation to teachers to attain success in e-learning implementation. The success of today's teachers' e-learning integration is largely reliant on the effective investment of digital from schools' stakeholders, especially policymakers, who are encouraged to refine and redevelop the technology strategic plan to ensure successful e-learning implementation in public schools. Digital investment management for teachers in e-learning integration is critical to ensure a pipeline of qualified educators.

Research gaps can be explored for future research directions. First, beliefs and motivation are internal, unseen, and complicated aspects of what one knows and what encourages one to act. Teachers' attitudes can be seen when their actions reflect their attitudes. Nevertheless, attitudes remain hard to quantify because they can shift due to a change in beliefs. The literature's definitions of teacher beliefs, motivation, and attitudes are diverse and challenging to define. As a result, these elements require additional clarification. Second, limited studies have been conducted on teachers' readiness. As a result, teachers' attitudes and motivation in successful e-learning implementation have been highlighted; hence this field requires further investigation. Third, future research could focus on assisted performance as this is one of the elements that can benefit educational stakeholders by implementing collaborative aspects needed for 21st-century skills. As stated in the school's subsections of "e-learning policy planning and strategies", the success of e-learning integration depends on the actions taken by school stakeholders to obtain the school's vision. Hence, it is important to portray the culture of each school in the school policy. These three interrelated elements need to be discussed extensively. These research gaps highlight the need for further equitable access to and utilization of technological resources for the purpose of digital transformation in education. Indeed, school budget allocation is an essential aspect of e-learning implementation success.

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REFERENCES

- [1] N. A. Razak, H. A. Jalil, S. E. Krauss, and N. A. Ahmad, "Teachers' Successful Information and Communication Technology Integration in Primary School: A Malaysian Cultural-Historical Case Study," *International Journal of Information and Communication Technology Education*, vol. 17, no. 4, pp. 1–18, 2021, doi: <https://doi.org/10.4018/IJICTE.20211001.0a4>.
- [2] W. Luo, I. R. Berson, M. J. Berson, and H. Li, "Are early childhood teachers ready for digital transformation of instruction in Mainland China? A systematic literature review," *Children and Youth Services Review*, vol. 120, p. 105718, Jan. 2021, doi: [10.1016/j.childyouth.2020.105718](https://doi.org/10.1016/j.childyouth.2020.105718).
- [3] A. Esfijani and B. E. Zamani, "Factors influencing teachers' utilisation of ICT: The role of in-service training courses and access," *Research in Learning Technology*, vol. 28, no. 1063519, pp. 1–16, 2020, doi: [10.25304/rlt.v28.2313](https://doi.org/10.25304/rlt.v28.2313).
- [4] A. W. Mogwe and P. A. Balotlegi, "Barriers of information communication technology (ICT) adoption in Botswanas' primary education," *Journal of Education and Learning (EduLearn)*, vol. 14, no. 2, pp. 217–226, 2020, doi: [10.11591/edulearn.v14i2.15312](https://doi.org/10.11591/edulearn.v14i2.15312).
- [5] M. Mahdum, H. Hadriana, and M. Safriyanti, "Exploring teacher perceptions and motivations," *Journal of Information Technology Education Research*, vol. 18, pp. 293–317, 2019, doi: [10.28945/4366](https://doi.org/10.28945/4366).
- [6] M. A. Arroyo, "A learning-centered approach to remote," UNLV Best Teaching Practices Expo, 2021. [Online]. Available: https://digitalscholarship.unlv.edu/btp_expo/147
- [7] T. Karakose, H. Polat, and S. Papadakis, "Examining Teachers' Perspectives on School Principals' Digital Leadership Roles and Technology Capabilities during the COVID-19 Pandemic," *Sustainability (Switzerland)*, vol. 13, no. 23, Dec. 2021, doi: [10.3390/su132313448](https://doi.org/10.3390/su132313448).
- [8] Organisation for Economic Co-operation and Development (OECD), "Youth and COVID-19 Response, recovery and resilience," Jun. 2020. [Online]. Available: <https://www.oecd.org/coronavirus/policy-responses/youth-and-covid-19-response-recovery-and-resilience-c40e61c6/>
- [9] United Nations, "Everyone Included: Social Impact of COVID-19," *United Nations*, 2020. [Online]. Available: <https://www.un.org/development/desa/dspd/everyone-included-covid-19.html>.
- [10] T. Karakose, R. Yirci, S. Papadakis, T. Y. Ozdemir, M. Demirkol, and H. Polat, "Science mapping of the global knowledge base on management, leadership, and administration related to COVID-19 for promoting the sustainability of scientific research," *Sustainability (Switzerland)*, vol. 13, no. 17, 2021, doi: [10.3390/su13179631](https://doi.org/10.3390/su13179631).
- [11] S. C. H. Yang, W. K. Vong, Y. Yu, and P. Shafto, "A unifying computational framework for teaching and active learning," *Topics in Cognitive Science*, vol. 11, no. 2, pp. 316–337, 2019, doi: [10.1111/tops.12405](https://doi.org/10.1111/tops.12405).
- [12] M. Fullan and J. Quinn, "How Do Disruptive Innovators Prepare Today's Students to Be Tomorrow's Workforce? Deep Learning: Transforming Systems to Prepare Tomorrow's Citizens," Inter-American Development Bank, 2020, doi: [10.18235/0002959](https://doi.org/10.18235/0002959).
- [13] K. Kaput, *Evidence for student-centered learning*. Saint Paul, MN: Education Evolving, 2018.
- [14] A. Mikheev, Y. Serkina, and A. Vasyaev, "Current trends in the digital transformation of higher education institutions in Russia," *Education and Information Technologies*, vol. 26, no. 4, pp. 4537–4551, 2021, doi: [10.1108/TR-09-2013-0047](https://doi.org/10.1108/TR-09-2013-0047).
- [15] Y. Qarkaxhja, N. I. Kryukova, Y. A. Cherezova, S. N. Rozhnov, E. R. Khairullina, and A. R. Bayanova, "Digital transformation in education: Teacher candidate views on mobile learning," *International Journal of Emerging Technologies in Learning*, vol. 16, no. 19, pp. 81–93, 2021, doi: [10.3991/ijet.v16i19.26033](https://doi.org/10.3991/ijet.v16i19.26033).
- [16] L. B. E. Villar, L. L. Herrero, and G. Álvarez-López, "UNESCO strategy and digital policies for teacher training: The deconstruction of innovation in Spain," *Journal of New Approaches in Educational Research*, vol. 11, no. 1, pp. 15–30, 2022, doi: [10.7821/naer.2022.1.812](https://doi.org/10.7821/naer.2022.1.812).
- [17] P. Giavrimis, S. Giossi, and A. Papastamatis, "Teachers' attitudes towards training in ICT: A critical approach," *Quality Assurance in Education*, vol. 19, no. 3, pp. 283–296, 2011, doi: [10.1108/09684881111158072](https://doi.org/10.1108/09684881111158072).
- [18] L. Sumardi, "Does the teaching and learning process in primary schools correspond to the characteristics of the 21st century learning?" *International Journal of Instruction*, vol. 13, no. 3, pp. 357–370, 2020, doi: [10.29333/iji.2020.13325a](https://doi.org/10.29333/iji.2020.13325a).
- [19] P. A. Ertmer, A. T. Ottenbreit-Leftwich, O. Sadik, E. Sendurur, and P. Sendurur, "Teacher beliefs and technology integration practices: A critical relationship," *Computers and Education*, vol. 59, no. 2, pp. 423–435, Sep. 2012, doi: <https://doi.org/10.1016/j.compedu.2012.02.001>.
- [20] P. A. Ertmer, "Addressing first-and second-order barriers to change: Strategies for technology integration," *Educational Technology Research and Development*, vol. 47, no. 4, pp. 47–61, 1999.
- [21] J. W. Creswell, *Qualitative Inquiry & Research Design, Choosing Among Five Approaches*. Thousand Oaks, California: Sage Publications, Inc., 2007.
- [22] J. Corbin and A. C. Strauss, *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*, 3rd ed. Beverly Hills, CA: Sage Publications, Inc., 2008.
- [23] W. Z. W. Ali, H. M. Nor, A. Hamzah, and H. Alwi, "The conditions and level of ICT integration in Malaysian smart schools," *International Journal of Education and Development using Information and Communication Technology*, vol. 5, no. 2, pp. 21–31, 2009. [Online]. Available: <https://www.learntechlib.org/p/42320>.
- [24] S. Divaharan and C. P. Lim, "Secondary school socio-cultural context influencing ICT integration: A case study approach," *Australasian Journal of Educational Technology*, vol. 26, no. 6, pp. 741–763, 2010, doi: <https://doi.org/10.14742/ajet.1040>.
- [25] N. J. Al-zaidiyeen and L. L. Mei, "Teachers' attitudes and levels of technology use in classrooms: The case of Jordan schools," *International Education Studies*, vol. 3, no. 2, pp. 211–219, 2010, doi: https://doi.org/10.1207/s15326985ep2501_6.
- [26] E. M. Rogers, *Diffusion of Innovations*, 4th Ed. the Free Press, New York, 1995.
- [27] M. Fullan, *Leading in a Culture of Change*. US: John Wiley & Sons, Inc, 2002.
- [28] Y. Engeström, *Learning by Expanding: An Activity Theoretical Approach to Developmental Research*. Helsinki: Orienta-Konsultit Oy, 1987.
- [29] J. Tondeur, M. Cooper, and C. P. Newhouse, "From ICT coordination to ICT integration: A longitudinal case study," *Journal of Computer Assisted Learning*, vol. 26, no. 4, pp. 296–306, 2010, doi: [10.1111/j.1365-2729.2010.00351.x](https://doi.org/10.1111/j.1365-2729.2010.00351.x).
- [30] G. Sang, M. Valcke, J. van Braak, J. Tondeur, and C. Zhu, "Predicting ICT integration into classroom teaching in Chinese primary schools: Exploring the complex interplay of teacher-related variables," *Journal of Computer Assisted Learning*, vol. 27, no. 2, pp. 160–172, 2011, doi: <https://doi.org/10.1111/j.1365-2729.2010.00383.x>.
- [31] S. Higgins and D. Moseley, "Teachers' Thinking about ICT and Learning: Beliefs and Outcomes," *Teacher Development*, vol. 5, no. 2, pp. 191–210, 2001.
- [32] G. Wikan and T. Molster, "Norwegian secondary school teachers and ICT," *European Journal of Teacher Education*, vol. 34, no. 2, pp. 209–218, 2011, doi: <https://doi.org/10.1080/02619768.2010.543671>.

- [33] H. Kim, H. Choi, J. Han, and H.-J. J. So, "Enhancing teachers' ICT capacity for the 21st century learning environment: Three cases of teacher education in Korea Teacher ICT capacity for the 21st Century learning," *Australian Journal of Educational Technology*, vol. 28, no. 6, pp. 965–982, 2012, doi: <https://doi.org/10.14742/ajet.805>.
- [34] S. Prestridge, "The beliefs behind the teacher that influences their ICT practices," *Computers and Education*, vol. 58, no. 1, pp. 449–458, 2012, doi: [10.1016/j.compedu.2011.08.028](https://doi.org/10.1016/j.compedu.2011.08.028).
- [35] L. Starkey, "Teachers' pedagogical reasoning and action in the digital age," *Teachers and Teaching*, vol. 16, no. 2, pp. 233–244, 2010, doi: [10.1080/13540600903478433](https://doi.org/10.1080/13540600903478433).
- [36] M. Judge, "Mapping out the ICT integration terrain in the school context: Identifying the challenges in an innovative project," *Irish Educational Studies*, vol. 32, no. 3, pp. 309–333, 2013, doi: [10.1080/03323315.2013.826398](https://doi.org/10.1080/03323315.2013.826398).
- [37] M. Prensky, "Digital Natives, Digital Immigrants Part 2: Do they really think differently," *On the Horizon*, vol. 9, no. 6, pp. 1–6, 2001, doi: [10.1108/10748120110424843](https://doi.org/10.1108/10748120110424843).
- [38] T. M. Mama and S. Hennessy, "Developing a typology of teacher beliefs and practices concerning classroom use of ICT," *Computers and Education*, vol. 68, pp. 380–387, 2013, doi: [10.1016/j.compedu.2013.05.022](https://doi.org/10.1016/j.compedu.2013.05.022).
- [39] Y. Engestrom, "Expansive learning at work: Toward an activity theoretical reconceptualization," *Journal of Education and Work*, vol. 14, no. 1, pp. 133–156, 2001, doi: [10.1080/13639080020028747](https://doi.org/10.1080/13639080020028747).
- [40] J. Copriady, "Self-motivation as a mediator for teachers' readiness in applying ICT in teaching and learning," *Procedia - Social and Behavioral Sciences*, vol. 176, pp. 699–708, 2015, doi: [10.1016/j.sbspro.2015.01.529](https://doi.org/10.1016/j.sbspro.2015.01.529).
- [41] L. Y. Tay, C. P. Lim, and S. K. Lim, "Differences in ICT Usage Across Subject Areas: A Case of an Elementary School in Singapore," *Journal of Educational Computing Research*, vol. 53, no. 1, pp. 75–94, 2015, doi: <https://doi.org/10.1177/0735633115585930>.
- [42] G. Ivey and P. H. Johnston, "Engaged reading as a collaborative transformative practice," *Journal of Literacy Research*, vol. 47, no. 3, pp. 297–327, 2015, doi: [10.1177/1086296X15619731](https://doi.org/10.1177/1086296X15619731).
- [43] J. Rabah, "Benefits and challenges of information and communication technologies (ICT) integration in Québec English schools," *The Turkish Online Journal of Educational Technology*, vol. 14, no. 2, pp. 24–31, 2015.
- [44] C. Buabeng-Andoh, "ICT usage in Ghanaian secondary schools: Teachers' perspectives," *International Journal of Information and Learning Technology*, vol. 32, no. 5, pp. 300–312, 2015, doi: <http://dx.doi.org/10.1108/IJILT-09-2015-0022>.
- [45] H. Mirzajani, R. Mahmud, A. F. Mohd Ayub, and S. L. Wong, "Teachers' acceptance of ICT and its integration in the classroom," *Quality Assurance in Education*, vol. 24, no. 1, pp. 26–40, 2016, doi: [10.1108/QAE-06-2014-0025](https://doi.org/10.1108/QAE-06-2014-0025).
- [46] K. Goodnough, "Professional learning of K-6 teachers in science through collaborative action research: An activity theory analysis," *Journal of Science Teacher Education*, vol. 27, no. 7, pp. 747–767, 2016, doi: <https://doi.org/10.1007/s10972-016-9485-0>.
- [47] J. P. Y. Ho, D.-T. Victor Chen, and D. Ng, "Distributed leadership through the lens of Activity Theory," *Educational Management Administration and Leadership*, vol. 44, no. 5, pp. 814–836, 2016, doi: [10.1177/1741143215570302](https://doi.org/10.1177/1741143215570302).
- [48] H. Ziyad, "Integrating computers in the classroom: Barriers and teachers' attitudes," *International Journal of Instruction*, vol. 9, no. 1, pp. 65–78, 2016, doi: [10.12973/iji.2016.916a](https://doi.org/10.12973/iji.2016.916a).
- [49] S. Munyengabe, Z. Yiyi, H. Haiyan, and Sabin Hitimana, "Primary teachers' perceptions on ICT integration for enhancing teaching and learning through the implementation of one laptop per child program in primary schools of Rwanda," *EURASIA Journal of Mathematics, Science and Technology Education*, vol. 13, no. 11, pp. 7193–7204, 2017, doi: <https://doi.org/10.12973/ejmste/79044>.
- [50] M. J. Koehler, P. Mishra, and William Cain, "What is Technological Pedagogical Content Knowledge?" *Contemporary Issues in Technology and Teacher Education*, vol. 9, no. 1, pp. 60–70, 2013, [Online]. Available: <https://citejournal.org/volume-9/issue-1-09/general/what-is-technological-pedagogical-content-knowledge>.
- [51] B. A. Dube, E. Nhamo, and S. Magonde, "Factors affecting ICT integration in the teaching and learning of physical education in South Africa: A Case of Johannesburg East cluster primary schools in the Gauteng Province," *International Journal of Sport, Exercise and Health Research*, vol. 2, no. 1, pp. 88–92, 2018.
- [52] E. Y. Loong and S. Herbert, "Primary school teachers' use of digital technology in mathematics: The complexities," *Mathematics Education Research Journal*, vol. 30, pp. 475–498, 2018, doi: <https://doi.org/10.1007/s13394-018-0235-9>.
- [53] D. Romrell, L. Kidder, and E. Wood, "The SAMR model as a framework for evaluating mlearning," *Online Learning Journal*, vol. 18, no. 2, pp. 1–15, 2014.
- [54] E. Ifinedo, J. Rikala, and T. Hämäläinen, "Factors affecting Nigerian teacher educators' technology integration: Considering characteristics, knowledge constructs, ICT practices and beliefs," *Computers & Education*, vol. 146, p. 103760, Mar. 2020, doi: <https://doi.org/10.1016/j.compedu.2019.103760>.
- [55] N. A. Razak, H. A. Jalil, and I. A. Ismail, "Challenges in ICT integration among Malaysian public primary education teachers: The roles of leaders and stakeholders," *Emerging Technologies in Learning*, vol. 14, no. 24, pp. 184–205, 2019, doi: [10.3991/ijet.v14i24.12101](https://doi.org/10.3991/ijet.v14i24.12101).
- [56] L. S. Vygotsky, *Mind in Society: The Development of Higher Psychological Processes*. US: Harvard University Press, 1997.
- [57] S. Li, S. Yamaguchi, J. Sukhbaatar, and J. Takada, "The influence of teachers' professional development activities on the factors promoting ICT integration in primary schools in Mongolia," *Education Sciences*, vol. 9, no. 78, pp. 2–18, 2019, doi: [10.3390/educsci9020078](https://doi.org/10.3390/educsci9020078).
- [58] B. Bai, J. Wang, and C. Chai, "Understanding Hong Kong primary school English teachers' continuance intention to teach with ICT," *Computer Assisted Language Learning*, vol. 34, no. 4, pp. 528–551, 2019, doi: [10.1080/09588221.2019.1627459](https://doi.org/10.1080/09588221.2019.1627459).
- [59] P. Amelia, D. Rukmini, J. Mujiyanto, and D. A. Linggar, "The development of English teachers' TPACK: The case of teaching English to young learners in primary schools," *International Journal of Advanced Science and Technology*, vol. 29, no. 4, pp. 2948–2957, 2020.
- [60] E. M. Mulenga and J. M. Marbán, "Prospective teachers' online learning mathematics activities in the age of COVID-19: A cluster analysis approach," *EURASIA Journal of Mathematics, Science and Technology Education*, vol. 16, no. 9, 2020, doi: <https://doi.org/10.29333/ejmste/8345>.
- [61] A. Edwards and H. Daniels, "Using sociocultural and activity theory in educational research," *Educational Review*, vol. 56, no. 2, pp. 107–111, 2004, doi: <https://doi.org/10.1080/0031910410001693191>.
- [62] A. Perienen, "Frameworks for ICT integration in mathematics education - A teacher's perspective," *EURASIA Journal of Mathematics, Science and Technology Education*, vol. 16, no. 6, 2020, doi: <https://doi.org/10.29333/ejmste/7803>.
- [63] A. Kjellsdotter, "What matter(s)? A didactical analysis of primary school teachers' ICT integration," *Journal of Curriculum Studies*, vol. 52, no. 6, pp. 823–839, 2020, doi: [10.1080/00220272.2020.1759144](https://doi.org/10.1080/00220272.2020.1759144).

- [64] H. Qaddumi, B. Bartram, and A. L. Qashmar, "Evaluating the impact of ICT on teaching and learning: A study of Palestinian students' and teachers' perceptions," *Education and Information Technologies*, vol. 26, pp. 1865–1876, 2020, doi: 10.1007/s10639-020-10339-5.
- [65] F. J. M. Veiga and A. M. V. de Andrade, "Critical success factors in accepting technology in the classroom," *International of Emerging Technologies in Learning*, vol. 16, no. 18, pp. 4–22, 2021, doi: <https://doi.org/10.3991/ijet.v16i18.23159>.
- [66] N. Omar and H. Hashim, "A Survey on the Acceptance of E-Learning for Professional Development amongst English as a Second Language (ESL) Teachers in Malaysia," *Creative Education*, vol. 12, no. 05, pp. 1027–1039, 2021, doi: <https://doi.org/10.4236/ce.2021.125075>.
- [67] N. Hafiza Hamzah, M. Khalid, and J. A. Wahab, "The effects of principals' digital leadership on teachers' digital teaching during the Covid-19 pandemic in Malaysia," *Journal of Education and e-Learning Research*, vol. 8, no. 2, pp. 216–221, 2021, doi: 10.20448/journal.509.2021.82.216.221.
- [68] A. A. P. Cattaneo, C. Antonietti, and M. Rausedo, "How digitalised are vocational teachers? Assessing digital competence in vocational education and looking at its underlying factors," *Computers and Education*, vol. 176, p. 104358, 2022, doi: 10.1016/j.compedu.2021.104358.
- [69] G. Knezek and R. Christensen, "Extending the will, skill, tool model of technology integration: Adding pedagogy as a new model construct," *Journal of Computing in Higher Education*, vol. 28, no. 3, pp. 307–325, 2016, doi: 10.1007/s12528-016-9120-2.
- [70] L. Shulman, "Those who understand: Knowledge growth in teaching," *Educational Researcher*, vol. 15, no. 2, pp. 4–14, 1986, doi: 10.3102/0013189X015002004.
- [71] I. Zhorova, O. Kokhanovska, O. Khudenko, N. Osypova, and O. Kuzminska, "Teachers' training for the use of digital tools of the formative assessment in the implementation of the concept of the new Ukrainian school," *Educational Technology Quarterly*, vol. 2022, no. 1, pp. 56–72, 2022, doi: <https://doi.org/10.55056/etq.11>.
- [72] R. Tharp and R. Gallimore, "Rousing minds to life: Teaching, learning and schooling in social context," *Journal of Design Research*, vol. 5, no. 2, pp. 155–171, 1988, doi: 10.1017/CBO9781139173698.
- [73] I. Kalas et al., *ICT in Primary Education Volume 1: Exploring the Origins, Settings and Initiatives*. United Nations Educational, Scientific and Cultural Organization (UNESCO), 2012.
- [74] L. Y. Tay and C. P. Lim, "An activity theoretical approach towards distributed leadership for one-to-one computing in a Singapore elementary school," in D. S. P. Gedera and P. J. Williams, Eds., *Activity Theory in Education*, Netherlands: Sage Publications, Inc, 2016, pp. 87–106.
- [75] T. Karakose, R. Yirci, and S. Papadakis, "Exploring the interrelationship between covid-19 phobia, work–family conflict, family–work conflict, and life satisfaction among school administrators for advancing sustainable management," *Sustainability (Switzerland)*, vol. 13, no. 15, 2021, doi: <https://doi.org/10.3390/su13158654>.
- [76] L. S. Anderson, *Technology planning: It's more than computers*. National Center for Technology Planning, 1999.
- [77] R. Maslowski, *School Culture and School Performance: An Explorative Study into the Organizational Culture of Secondary Schools and Their Effects*. University of Twente Press, 2001.
- [78] J. Calderhead, "Teachers: Beliefs and knowledge," *Handbook of Educational Psychology*, Macmillan Library Reference USA, Prentice Hall International 1996, pp. 709–725.
- [79] D. H. Schunk, "Goal setting and self-efficacy during self-regulated learning," *Educational Psychologist*, vol. 25, no. 1, pp. 71–86, 1990, doi: https://doi.org/10.1207/s15326985ep2501_6.
- [80] C. Ames, "Classrooms: Goals, structures, and student motivation," *Journal of Educational Psychology*, vol. 84, no. 3, pp. 261–271, 1992, doi: 10.1037/0022-0663.84.3.261.
- [81] M. Fishbein and I. Ajzen, *Belief, Attitude, Intention and Behaviour: An Introduction to Theory and Research*. Reading MA: Addison-Wesley, 1975.
- [82] I. Ajzen and M. Fishbein, "Understanding attitudes and predicting social behaviour," *Englewood cliffs: Prentice Hall*, 1980.
- [83] I. Ajzen, "From Intention to Actions: A Theory of Planned Behavior," in *Action Control*, 1985, pp. 11–39.
- [84] I. Ajzen, "The theory of planned behavior," *Organizational Behavior and Human Decision Processes*, vol. 50, no. 2, pp. 179–211, Dec. 1991, doi: 10.1016/0749-5978(91)90020-T.
- [85] F. D. Davis, A technology acceptance model for empirically testing new end-user information systems: Theory and results. Sloan School of Management, Massachusetts Institute of Technology, 1986.
- [86] V. Venkatesh, M. G. Morris, G. B. Davis, and F. D. Davis, "User acceptance of information technology: Toward a unified view," *MIS Quarterly*, vol. 27, no. 3, pp. 425–478, 2003, doi: <https://doi.org/10.2307/30036540>.
- [87] M. Cole, "The Zone of Proximal Development: Where Culture and Cognition Create Each Other," in J. V. Wertsch, Ed. *Culture, communication, and cognition: Vygotskian perspectives*, 1st ed., Unites States of America: Cambridge University Press, 1985.
- [88] L. C. Yamagata-Lynch, *Activity Systems Analysis Method: Understanding Complex Learning Environments*. New York: Springer, 2010.
- [89] A. R. Luria, "The problem of the cultural behavior of the child," *Pedagogical Seminary and Journal of Genetic Psychology*, vol. 35, no. 4, pp. 493–506, 1928, doi: 10.1080/08856559.1928.10532168.
- [90] Y. Engestrom, *Learning by Expanding: An Activity-Theoretical Approach to Developmental Research*, Second ed. Cambridge University Press, 2019.
- [91] P. W. Harry Daniels, "Analysing third generation activity systems: Labour-power, subject position and personal transformation," *Journal of Workplace Learning Analysing*, vol. 19, no. 6, pp. 377–391, 2007, doi: <https://doi.org/10.1108/13665620710777110>.
- [92] Y. Engestrom and H. Kerosuo, "From workplace learning to inter-organizational learning and back: the contribution of activity theory," *Journal of Workplace Learning Analysing*, vol. 19, no. 6, pp. 336–342, 2007, doi: <https://doi.org/10.1108/13665620710777084>.
- [93] N. A. Razak, H. A. Jalil, S. E. Krauss, and N. A. Ahmad, "Successful implementation of information and communication technology integration in Malaysian public schools: An activity systems analysis approach," *Studies in Educational Evaluation*, vol. 58, pp. 17–29, 2018, doi: <https://doi.org/10.1016/j.stueduc.2018.05.003>

BIOGRAPHIES OF AUTHORS

Nor Asiah Razak    is a Senior Lecturer in the Computing Department, Faculty of Art, Computing and Creative Industry, Sultan Idris Education University (UPSI). Her research focuses on information and communication technology (ICT) in education with a specialization in 21st-century teaching environments. She is currently appointed as the Coordinator of Bachelor of Software Engineering (Educational Software), UPSI. She also is a reviewer for national and international journals. She can be contacted at email: norasiah.razak@meta.upsi.edu.my.



Roznim Mohamad Rasli    is a Senior Lecturer in the Computing Department, Faculty of Art, Computing and Creative Industry who has served for almost 15 years at the Sultan Idris Education University (UPSI). Her areas of expertise are artificial intelligence, data mining and knowledge management. She is currently engaged as the Coordinator of Association, Art and Culture at Co-Curriculum Centre, UPSI, as well as being an Advisor to the Software Engineering Association. She can be contacted at email: roznim@fskik.upsi.edu.my.



Suvarmani Subban    is a Director at the Prime Minister Department, as well as Director of Education and Training Section (MITRA), Minister of National Unity (Malaysia). He was the former Ass. Director at the Education Planning Research Division, MOE, responsible for educational project development and special projects. Also, as Smart School Coordinator in Smart School Pilot Project Malaysia, MOE. He can be contacted at email: suvarmani@smkpp16.edu.my.



Nor Aniza Ahmad    is an Associate Professor at the Universiti Putra Malaysia (UPM), in the Faculty of Educational Studies. She is interested in understanding learning sciences research and shaping learning in a number of settings such as schools, workplaces, and higher education. She is actively involved in academic research and has become a lead researcher and co-researcher in 14 research grants from UPM, Ministry of Education and international collaboration. She can be contacted at email: nor_aniza@upm.edu.my.



Shazia Malik    is an Assistant Professor at Institute of Education and Research, University of the Punjab Lahore, Pakistan. She has completed PhD Education from University Putra Malaysia with specialization in the area of Curriculum and Instruction. She has published almost 17 research papers in national and international journals. She can be contacted at email: shazia.ier@pu.edu.pk.