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Pedagogical Knowledge for Technology-Enhanced Learning

A Literature Review

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ABSTRACT

The inexorable growth of technological use amidst COVID-19 strengthens the emerging paradigm in education and accelerates the need for technology-supported pedagogical knowledge. This paper examines how the principles of the four learning theories, behaviourism, cognitivism, constructivism, and connectivism, are implemented in the technology-enhanced learning environment to help faculty align their pedagogy and teaching methods with technology. A review is conducted to survey relevant literature concerning learning theories and pedagogical models to achieve this goal. This review relies on four major bibliographic databases: Science Direct, Scopus, Web of Science, and Google Scholar, through which many articles are identified. Twenty-seven articles are selected according to the scope of the study. Then, a qualitative analysis is conducted to determine the four learning theories implemented in the online environment. The proposed pedagogical framework classifies the four learning theories in a hierarchical hierarchy according to their adherence to the student-centred learning approach. Connectivism is at the top of the pyramid due to its vast opportunities for learners' autonomy, interactivity, and diversity. Constructivism precedes as it is also centred on learners, allowing for knowledge construction.

Introduction

The COVID-19 pandemic has led to abrupt new educational challenges, establishing a significant paradigm shift in teaching and learning. The overwhelming urge toward distance education due to the closure of Universities and colleges hastened teachers' use of technology despite the factors that may hinder their adoption of new technology. These factors, as they have been referred to in the existing literature, concern teachers' attitudes, readiness, acceptance, resistance, self-efficacy perceptions, perceived usefulness, perceived ease of use, and behavioral intentions, as it is stated in [1]-[8]. It can be noticed that the context of emergency online teaching during the pandemic altered the regular longitudinal teachers' perceptions, preparation, and readiness to use technology to the extent of generating new optimistic sentiments like humility, enthusiasm, and empathy between teachers and students as it is stated in [9]. As a result, e-learning has flourished despite the pandemic's social, economic, political, and psychological disruptions. In the cases of total or partial closures amidst the lockdown in different parts of the world, distance education remained the most, if not the only, alternative for teachers and learners. Nevertheless, teachers' decisions and good intentions to resort to e-learning did not guarantee a smooth transition to online instruction and effective pedagogical use of technology. One of the reasons is that the online learning environment disrupts teachers' traditional pedagogical practices as it requires new adjustments to the new learning teaching opportunities offered by technology. Given that pedagogical methods are based on learning theories, this paper examines how the principles of the four learning theories, behaviourism, cognitivism, constructivism, and connectivism, are implemented in the technology-enhanced learning environment. Therefore, the paper aims to answer the following research questions: How do traditional learning theories apply to the online environment? What are the emerging pedagogical models in each learning theory?

Answering these questions requires the analysis of the relevant literature concerning learning theories: behaviourism, cognitivism, constructivism, and connectivism about the online environment. Then, the emerging pedagogies, critical thinking, student-centred learning, learners' pace of learning, collaborative learning, learning by doing, and self-directed learning are examined within their suitable learning theories. This paper aims to assist teachers in the process of aligning the traditional approaches to the online environment for a better understanding of online teaching pedagogy and to design solid didactic activities and highly effective Information Communication Technology (ICT) teaching practices.

Literature Review

While this paper does not provide a comprehensive review of the four major learning theories of learning, it is still important to refer to their principles to set a solid basis for

pedagogy. In Behaviorism, learning occurs due to observable external behaviour in sequences of stimulus-response relationships [10]. One type of learning, classical conditioning, was introduced by Ivan Pavlov to support the idea that learning alters according to the interpretation of incoming stimuli. Operant conditioning, introduced by B.F Skinner, is another learning that associates behaviour with consequences, rewards and punishments [11].

Aside from behaviourism, cognitivism views learning as a cognitive process whereby learners use their mental abilities to process information [12]-[16]. Gestalt learning theories claim that learning is achieved through perception, insight, and meaning since individual learners are involved in organising and interpreting meaningful experiences. Piaget [14] raises the issue of developmental changes in the nervous system resulting from various learning experiences and environments. So, learners are viewed as individuals equipped with a mental capacity to deal with content through organisation, reasoning, categorisation, coding, transferring, etc.

According to the theory of constructivism, learners construct knowledge through their involvement in the learning process, as stated in Ref. [17]. Ref. [18] refers to two major constructivist perspectives: cognitive constructivism and the socio-constructivist perspective. Cognitive constructivism is based on the work of Piaget [19], who claims that learners develop cognitive abilities through assimilation or accommodation. Assimilation is when learners associate new information with what they already know to assimilate it into their existing knowledge. In contrast, accommodation is resorted to in the case of challenging learning situations when learners adapt their mental structures to the learning environment. As for the socio-constructivist perspective, Ref. [15] recognizes the social aspect of learning, which develops from social communication to the individual. While Vygotsky believes that social learning paves the way to cognitive development, Piaget emphasizes the primacy of thought over speech. Even though the internalization of social speech is apparent in adulthood, Vygotsky claims to preserve its intrinsic collaborative character [18].

Even though connectivism fails to add to the principles of the existing learning theories through the explanation of the process of learning within technology, it is still the first attempt to reconsider the effects of technology on learning [20]. Learning theories fail to recognise the external dimension of learning as it is guided by technology and how it happens within organisations, as stated in Ref. [21]. Therefore, connectivism is introduced as an alternative learning theory that connects learning to diverse opinions, the interaction between specialised communities or information sources, and up-to-date knowledge and technological tools. This diversity of communities and information is the "epitome of connectivism" as it allows for the "amplification of learning, knowledge, and understanding through the extension of a personal network", as stated in Ref. [21]. To create a reliable network, Ref. [22] identifies four

fundamental principles: autonomy, diversity, openness, and interactivity. Autonomy recognises individuals as independent entities who can act independently, make choices, and minimise external control. As for diversity, individuals' distinct characteristics, such as race, gender, and socioeconomic status, are acknowledged. The connectivist environment is also open regarding receiving and sharing external output like communication, expertise, ideas, resources, and insights through interactivity and connectedness [23].

Material and Methods

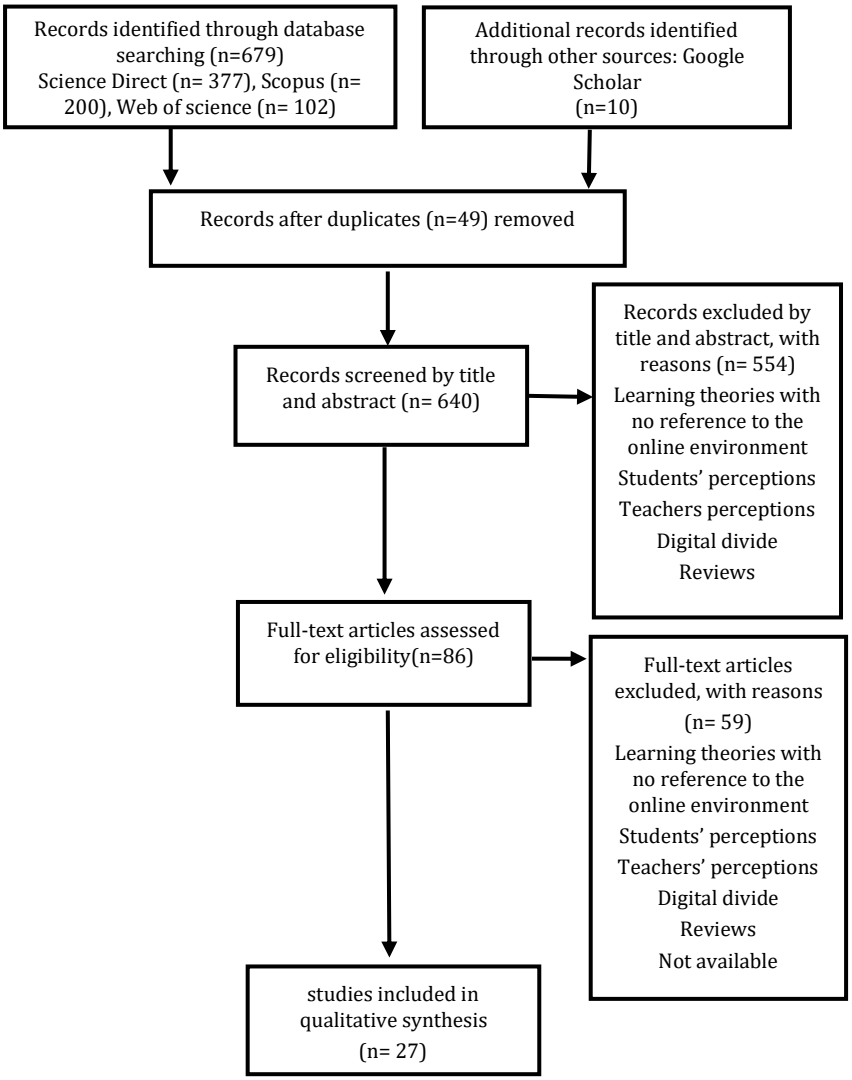
A. Search design

An extensive literature review was conducted to identify relevant research studies to answer the research questions. Collected articles for the review were retrieved using four electronic databases: Web of Science, Scopus, Science Direct and Google Scholar. The following key search terms were used: ["behaviourism and the online environment" OR "behaviourism and online instruction" AND ["cognitivism and the online environment" OR cognitivism and online instruction] AND ["constructivism and the online environment" OR "constructivism and online instruction] AND ["connectivism and the online environment OR "connectivism and online instruction"] AND ["learning theories and online learning"]. The selection of resources was restricted to the past 12 years, from 2010 to 2022, to focus on the latest trends and research studies in educational technology, which is continuously evolving rapidly. Yet, other relevant classic studies were also selected.

B. Selection process and criteria

This review uses an explicit method to identify, select, assess, and analyse relevant research. It conforms to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses, the PRISMA statement. Therefore, it uses the four-phase flow diagram to identify records through database searching, screen the titles and abstracts for articles that are relevant to research questions, assess these articles for eligibility, and then subtract the number of excluded articles during the eligibility review from the total number of papers. As demonstrated in Fig. 1 below, the initial search resulted in [n=689] records in total. This is the sum of [n=102] articles from Web of Science, [n=200] from Scopus, [n=377] from Science Direct, and [n=10] additional articles from Google Scholar. Then, a total of [n=49] duplicates were removed. The remaining articles [n=640] were screened by title and abstract, and those [n=554] that failed to meet the inclusion criteria were eliminated. As a result, the remaining articles were [n=86]. Then, full articles were assessed and summarised to examine their eligibility for inclusion (See Table 1). The articles that did not meet the inclusion criteria were

eliminated [n=59], and the ones that overlapped. The total number of studies selected for the qualitative analysis is [n= 27].



Source: Adapted from [24]

Fig. 1. The flow of information through the different phases of a systematic review

Table 1. Inclusion criteria

Criteria	Inclusion
Target Audience	Higher education
Learning environment	Online
Studies	Empirical studies focusing on the implementation of learning theories in online instruction
Research resources	Scholarly journal articles and books
Period	From 2010 to 2022 [other relevant and classic studies included]
Language	English

C. Data analysis

Data was extracted from the retrieved literature and analysed according to this paper's research questions. The critical criteria for paper selection are as follows: the four learning theories, behaviourism, cognitivism, constructivism and connectivism, the online environment, and pedagogical models. Then, the PICO framework, Problem, Intervention, Comparison, and Outcome are used to facilitate search strategy development. Even though the PICO statement is commonly used in clinical health studies, it is argued that it can also be used for all disciplines and with all study designs [25]. Therefore, the present paper uses the following universal PICO scheme, which differs slightly from the classical one.

Table 2. The Universal PICO scheme

Components of PICO	Components of all research design
Problem	Research object
Intervention	Application of a theory or method
Comparison	Alternative theories or methods [or, in their absence, the null hypothesis]
Outcome	Knowledge generation

Source: [25]

The first component of the framework is the Problem or the research object being observed. In the surveyed articles, Problem refers to learning theories, ICT tools, or innovative pedagogical models. The second component, Intervention, refers to implementing the aforementioned research objectives through which results are achieved. Comparison refers to the difference between theories, pedagogical models, ICT tools, or even between these and their absence. The last component, Outcome, is the added value of learning theories in technology-enhanced learning environments and/or new pedagogical models.

Results

Table 3 presents the results obtained from the selected studies. The PICO framework details them regarding the research object, the four learning theories and pedagogical models. The implementation of these research objects in the online environment is highlighted. Then, comparing the research objects to others or non-existing ones is also identified to emphasize their added value. The last component refers to the outcome resulting in knowledge generation to answer this paper's research questions.

Table 3. Studies by authors framed by the PICO method

No	Author	Problem	Intervention	Comparison	Outcome
1	[26]	College students' cognitive processing patterns in a collaborative problem-solving teaching activity integrating	45 students took an online course to teach basic networking concepts and develop their network troubleshooting abilities.	Relationship between cognitive abilities and collaborative construction of knowledge.	Students' network troubleshooting abilities improved. There are differences in sequential cognitive processing between

No	Author	Problem	Intervention	Comparison	Outcome
		Facebook discussion tools and simulation-based teaching software.	Quantitative analysis content codes online discussions and explores the cognitive levels. A lag sequential analysis was conducted to analyse the coding results of the analysis and assess the behavioural patterns during the discussion process. A pretest and a posttest are administered.		"discussion-centred" and "manipulation-centred" groups.
2	[27]	Overview of game-based learning [GBL] and the state of serious games [SGs] for environmental management as educational tools in higher education.	The adoption of different learning orientations [e.g., behaviourism, cognitivism, humanism and constructivism] in serious games can expand the horizons of learning objectives and improve different areas such as cognitive development, acquisition of factual knowledge, teamwork skills, critical thinking skills, and creative problem solving, among others can be developed.	The multiple learning theories [e.g., experiential and self-directed learning] that arise from different learning principles and orientations are of great importance to the notion of GBL as they encompass the principles behind "how" and "why" SGs can teach what they are intended to teach. If games with worthwhile learning objectives are knowledgeably designed in which students enjoy participation, the time spent learning could significantly increase.	The effectiveness of games is not universal for educational purposes. Many studies of educational games contain methodological problems and need more quantitative results. GBL increases students' motivation and engagement.
3	[28]	Learning theories and the online environment.	The implications of learning theories for ICT use.	The implication of behaviourism, cognitivism and constructivism in ICT use.	Constructivism transforms the traditional paradigm in teaching and learning and guides ICT use toward collaboration, sociability, discussion, problem-solving, authentic contexts, coaching, self-regulated learning [SRL], etc.
4	[29]	Blended learning and inquiry-based virtual reality [VR].	Research on blended learning, experiential learning, and inquiry-based learning.	VR is a new approach to e-learning which needs to be aligned with theoretical foundations such as cognitivism, constructivism, and connectivism.	The design of a standard aligned blended Learning VR inquiry framework and the presentation of a lesson model.

No	Author	Problem	Intervention	Comparison	Outcome
5	[20]	There needs to be a balance between technology and pedagogy in the technology enhanced learning domain.	Qualitative analysis of the most influential pedagogical theories, models, and frameworks.	The comparison of learning theories and frameworks and the presentation of the unique aspects of each one.	Learning theories are classified into associationist, cognitive, and situational perspectives. Learning theories complement rather than compete with each other.
6	[30]	The creation of an inclusive learning environment through the inverted classroom.	Teaching introductory economics at Miami University in the converted classroom format.	Traditional classroom vs. inverted classroom.	The strengths of the inverted classroom are faculty and student interaction, active learning, incorporation of large groups of learners, Technology such as PowerPoint presentations, websites, video and sound files facilitate the implementation of the inverted classroom.
7	[31]	Self-directed [SDL] and SRL in the online context.	A literature review of 30 empirical studies was conducted.	Comparison of SDL and SRL in the context of e-learning.	E-learning has not caused remarkable changes in how self-directed and self-regulated learning are understood and described. SDL and SRL are used as synonyms.
8	[32]	The use of ICT tools by EFL learners to self-regulate their language learning outside the formal instructional setting.	Surveys are conducted with 777 university students attending an intensive English language preparatory program.	Compared to the traditional environment, learners actively use ICT tools for self-regulated language learning.	EFL learners were actively using ICT tools for self-regulated language learning, especially for their goal commitment regulation, affective regulation, and resource regulation. ICT motivates EFL learners to work according to their pace, time, and level. And needs. Yet, EFL learners do not use ICT for metacognitive and social regulation, and there were variations among learners and in aspects of regulating learning through ICT tools.
9	[33]	Cognitive strategies of arts and humanities students when learning	Investigating students' cognitive abilities using a Robotics Serious Game through	Compared to the traditional learning environment, the robotic lab simulates	Cognitive activities in the educational robotics lab stimulate students'

No	Author	Problem	Intervention	Comparison	Outcome
		different Robotics concepts.	a pre and posttest on motivation and Project Based Learning [PBL] methodology.	students' motivation and engagement in learning.	motivation, curiosity, and interest.
10	[34]	Interactive tools of Web 2.0	The design of a University 2.0 model by advanced Web 2.0 tools	Without the university Web 2.0 model, there are fewer innovative pedagogical opportunities in instruction and research.	The University 2.0 model brings best practices to support teaching and research.
11	[35]	The effect of media and learning materials as instructional designs on individual learning outcomes based on Cognitive Load Theory.	Experimental method involving 173 participants to determine the effectiveness of instructional design in accounting. This study manipulated the experimental group through learning media [audiovisual and virtual reality] and accounting equation learning materials [traditional and nontraditional].	Unlike VR and audiovisual material, traditional learning materials involve learners in memorisation or forming new schemes to understand new knowledge. This working memory utilisation could be more optimal.	Individual learning performance and outcomes were higher when using VR. VR and nontraditional learning materials lower individuals' cognitive load.
12	[36]	Communal constructivist theory and ICT pedagogy.	The exploration of communal constructivism in several international ICT projects.	Without ICT, there are fewer opportunities for collaborative knowledge creation, especially in the need for online publishing tools and virtual community building.	Various forms of ICT are effective. They bring new opportunities to learning, such as virtual and authentic community building. New pedagogical practices arise, such as the collaborative construction of knowledge.
13	[37]	Constructivism and web 2.0 technologies to enhance collaboration.	Developing a language learning lesson based on constructivism and incorporating web 2.0 technologies in an online TESOL course.	Without the incorporation of technology, the instructional lesson would provide fewer opportunities for collaboration for students.	The instructional lesson design model guided lesson plan development. Technology provided opportunities for collaboration.
14	[38]	Social knowledge construction in e-discussions through roles assignment.	Asynchronous discussion groups of 10 first-year students in instructional sciences were organised to help students process the learning content.	Without synchronous discussion groups, time, place, and access are constraints. In classroom discussions, students need more time to retain role related activities.	Knowledge construction reaches higher levels due to role assignment. Role assignment in the long run [e-discussions] gives students more time to internalise role-related activities.
15	[39]	The potential of blogging amongst preservice teachers'	Narrative methodology involves	Preservice teachers have fewer opportunities to	The blogging space led to the collaboration of

No	Author	Problem	Intervention	Comparison	Outcome
		professional learning.	the analysis of participants' stories.	collaborate and personalise their teaching experiences without the digital blogging space.	preservice teachers to discuss their professional demands and pedagogical experiences to personalise their teaching profession.
16	[40]	Constructivism and electronic learning in nursing education.	Descriptive review to highlight the importance of electronic learning and the theory of constructivism.	The implementation of learning theories in technology-based lessons is limited compared to constructivism.	The presentation of a model for electronic learning using constructivism.
17	[41]	The effects of wikis on foreign language students' writing.	Pretests and posttests are conducted to investigate writing accuracy and quality.	There were significant differences in accuracy quality between the experimental and the controlled group taught using traditional methods.	Learning using wikis is effective in improving the subjects' accuracy in their writing.
18	[42]	Project-Based Learning [PBL] and mobile apps for learning 2D animation.	The integration of project-based learning in the design of mobile tutoring apps to assist students in creating and developing 2D animation tools and multimedia courseware applications.	Without PBL, learners have less control over their learning process.	By integrating project-based learning in the design and development of the apps, learners have more control over their learning process.
19	[43]	Enhancing Instruction through Constructivism, Cooperative Learning, and Cloud Computing	Suggesting strategies for integrating cloud-based applications for graduate education students learning about assessment.	Without the use of cloud computing technologies, cooperative learning and constructivism have limited learning	Graduate education students approved of using cloud computing technologies to enhance their understanding of assessment and instruction through content publishing, simultaneous written activities and collaboration in various activities.
20	[44]	Peer assessment in a computer-supported collaborative learning environment [wiki] in higher education	Involving two conditions: 1/structured peer feedback through a structured feedback form 2/non structured with no specific format A pretest and a posttest are conducted to examine students' insights about the main topics [behaviourism, cognitivism, and constructivism] over 9 weeks.	Without the computer-supported collaborative learning environment[wiki], students are not motivated and engaged to share work, and construct knowledge with other peers	There was a significant difference between the initial work's quality and the final product's quality. There was no significant difference in learning effect between the pretest and posttest scores. The structured peer feedback group adopted a more critical attitude than the non structured in

No	Author	Problem	Intervention	Comparison	Outcome
					giving and receiving profound and detailed feedback. profound
21	[45]	Constructivism and the use of technology	Examining the theory of constructivism and the factors contributing to the effective use of technology.	Traditional teaching approaches need to use technology effectively.	Constructivism is an appropriate framework for educational technology.
22	[46]	Instructivism and socioconstructivism through VR	The development of a virtual reality system on a desktop by deploying Visual Basic.NET, Java and Macromedia Flash.	Compared to a traditional two-dimensional interface, the virtual reality system approximates reality and allows students to explore and interact with virtual surroundings.	The VR system enhanced students' understanding by creating a sensory-rich interactive learning environment.
23	[47]	Wikis in an EFL writing classroom to facilitate collaboration and promote foreign language acquisition through a social constructivist perspective.	Two online questionnaires and interviews were conducted with 42 students on their reflections on using wikis for collaborative writing.	Due to its collaborative and interactive nature, a wiki relates more to the constructivist approach than other learning approaches.	Wikis increase the student's motivation to learn English, enhance their writing confidence and promote their initiatives for social constructivist learning. Collaboration on a wiki in an EFL setting contributes to language development and social interaction.
24	[48]	Collaborative approaches in e-learning.	State of art collaborative learning through a classification framework based on four views [subject, purpose, method, and tool].	Comparison of 10 collaborative e-learning approaches.	All approaches are based on pedagogical-based learning, scenario-based context, collaboration, interaction, evaluation, experimentation, synchronous and asynchronous communication, and they all promote collaborative learning.
25	[49]	Virtual Reality [VR] and Augmented Reality [AR] in social learning spaces	Qualitative review of the properties and interactions of VR and AR in social learning spaces in addition to several learning theories such as constructivism, social cognitive theory, connectivism and activity theory.	The interconnected learning processes within VR and AG necessitate alternative theoretical foundations to depict how this learning happens.	VR learning environments exploring 3D virtual environments and avatars are collaborative learning environments allowing for multiple forms of communication via text, camera, and voice.

No	Author	Problem	Intervention	Comparison	Outcome
					VR /AR learning depends on constructivism, experiential learning, social cognitive theory and activity theory.
26	[50]	The theory of connectivism and leadership.	A review of the theory of connectivism regarding the contributions of digital learning and leadership theory and development.	Connectivism is an alternative theory to the traditional learning theories as it is aligned with the new revolutionary technologies affecting research, learning, communication	The 21st-century "connectivist leadership" is characterised by dynamism, connectivity, and collectivity as it is rooted in digital knowledge and interpersonal networks.
27	[23]	Individual experience in a connective environment.	Expanding four critical principles of connectivism to recognise individual and psychological diversity.	Unlike connectivism, other learning theories are limited and do not respond to the complex interactions among psychologically diverse individuals.	Learners' involvement and interpretation of connectivity, autonomy, openness, and diversity vary considerably.

Discussion

Some computer-assisted instructions are based on behaviourist online environments, providing immediate feedback to reinforce accurate responses or reject false ones. Ref. [28] refers to examples like games on computers or mobile phones, which give feedback on performance in the form of scores verbal/textual/pictorial congratulatory messages. Other examples illustrating the stimulus-response association are Compact Discs and online courses containing icons like 'forward', 'backward', 'pause', 'start', 'skip', etc. Bose argues that a stimulus-response connection is established when users associate a particular action with a specific icon, and this involves learners in processes of drilling and practice to reinforce this association. The stimulus-response association is strengthened when users are led towards the same actions in case of repetitive button pressing. Even though the behaviourist principles frame learning within the boundaries of drill, practice, and mechanical associations, multimedia computers add other options, such as videotaped lectures and listening to PowerPoint with sound presentations [30].

In addition to these behaviourist learning principles, exploring learners' internal mental processes, which enable another form of learning is essential. Technology can potentially elicit learners' mental abilities by presenting logically sequenced structured content, summaries, examples, analogies, concept maps, etc., to facilitate information processing and promote critical thinking [28]. For example, writing skills can be exploited more effectively online than traditional face-to-face learning since teachers can enhance

student collaboration, encourage peer-editing and promote electronic writing on publishing tools like wikis, blogs, and forums. As a result, students can improve their lexico-grammatical accuracy and quality, as confirmed in a study exploring the effect of wikis on writing skills during the Preparatory Year [PY] at King Saud University in Saudi Arabia [41]. In addition to synchronous class discussions in physical and online classes, the online environment offers other opportunities for asynchronous talks in which students are more exposed to the content. Therefore, they have more time to generate more composed and thoughtful responses. Yet, online learning may cause both cognitive overload and disorientation. Ref. [19] refer to self-regulated learning to help overcome these difficulties by acquiring cognitive and meta-cognitive skills. Ref. [31] refer to the diagnosis of needs, formulation of learning goals, resource identification and selection, implementation of learning strategies, and evaluation of learning outcomes. In this respect, ICTs provide learners with myriads of resources in different formats to regulate their learning. A study examining the use of ICT tools to self-regulate language learning by English as a Foreign Language [EFL] learners indicates that participants handle different aspects of their learning, such as goal commitment regulation, affective regulation, and resources regulation, thanks to the use of ICTs [32]. A study exploring the use of Facebook as a discussion environment paired with Packet Tracer simulation software indicates the improvement of the participants' network troubleshooting abilities, in addition to the demonstration of the high-level cognitive phases, application and analysis [26]. It can be noticed that the participants' cognitive processes flourished in a collaborative online environment, which refers to the relationship between cognitive abilities and the collaborative construction of knowledge.

As for the association of computer-based educational technologies to the theory of constructivism, ICT brings different forms of virtual and real community building in which knowledge is constructed, shared, and published. Besides the characteristics of Communal Constructivist Pedagogy, such as collaboration with external communities, internationalisation of the curriculum, students as stakeholders of their learning, access to authentic and up-to-date knowledge, publishing of students' quality products, etc [36], they can be achieved through numerous Web 2.0 tools. Examples are discussion forums where learners can respond from a distance to faculty prompts and peer postings, as stated in [37], and publishing students' learning outputs on wikis or blogs. Not only do wikis/blogs allow learners to publish their products, but they also enable them to discuss each other's ideas. On wikis, they can collaboratively add, delete, and modify content directly from the web browser. This indeed results in improving the wiki product, as confirmed in a study examining the added value of peer assessment in a computer-supported collaborative learning environment in higher education on improving the wiki [44]. Another study exploring wikis use in an EFL

writing classroom referred to increased students' motivation, enhanced writing confidence, promoted collaborative activities, and language development for social constructivist learning [47]. As for blogging, it yields a personalised approach, as in the case of pre-service teachers in England who shared and valued each other's experiences while blogging with a sense of belonging, situating, and connecting [39]. A model of nursing education suggests several electronic technologies based on constructivism to design an effective online learning environment. These include blogs, e-mails, and video streaming to enhance active learning, collaboration, and interactivity. Discussion boards were also used for posting messages and podcasting to allow for sharing media files. Other technological devices, such as MP3 players, iPhones, and Personal Digital Assistants, were used in e-learning courses [40] and other cloud computing technologies, such as Google Docs and Microsoft Office Live. These foster instructional methods based on constructivism and cooperative learning when educators use them effectively [43]. Several strategies are suitable for these technologies, like content creation, group presentations, problem-solving tasks, and project-based assignments through which students are involved in knowledge construction to develop a course of action through social interaction with their peers. At the University of Technology in Malaysia, they are integrating Project-Based Learning into designing and developing mobile apps for learning 2D animations, allowing for authentic learning experiences. Students could construct their creativity by practising their technical skills and developing their products. More than that, the learning environment enhanced cooperation among team members as they reflected together, exchanged feedback, and gathered and discussed material [42]. It can be noticed that the aforementioned pedagogical models apply to the principles of cognitive constructivism and social constructivism since learners can develop both their cognitive abilities and social communication.

The technology-based learning environment extends the connective learning network by altering and enriching how and what people learn. The plethora of opportunities offered through various technological tools strengthens learners' autonomy to make independent choices in many contexts. The online environment also establishes a strong liaison among individuals of different cultures, races, beliefs, etc., who interact and connect through an online external output. This online output is a rich external environment where learners can perform tasks and combine and transform experiences. The development of Massive Open Online Courses (MOOCs) demonstrates the practical application of the principles of connectivism as they were created to bring many people together [50]. Other types of services, such as various instant messaging services, online collaboration tools, and software, help foster cooperation among learners. Ref. [48] clarifies that the emergence of social media tools reinforces the

adoption of collaboration techniques in teaching and learning environments as they enable the improvement of students' interaction, engagement, and collaboration through platforms like Personal Learning Environments, semantic wikis, multi-purpose collaborative platforms, integrated social learning environments, media Wikis platforms, Social Networking Forums, google apps services, MOOCs, and microblogging platforms. The results of this review lead to the development of a pedagogical framework to raise teachers' awareness concerning the pedagogical considerations framing their use of ICT tools to achieve their learning outcomes.

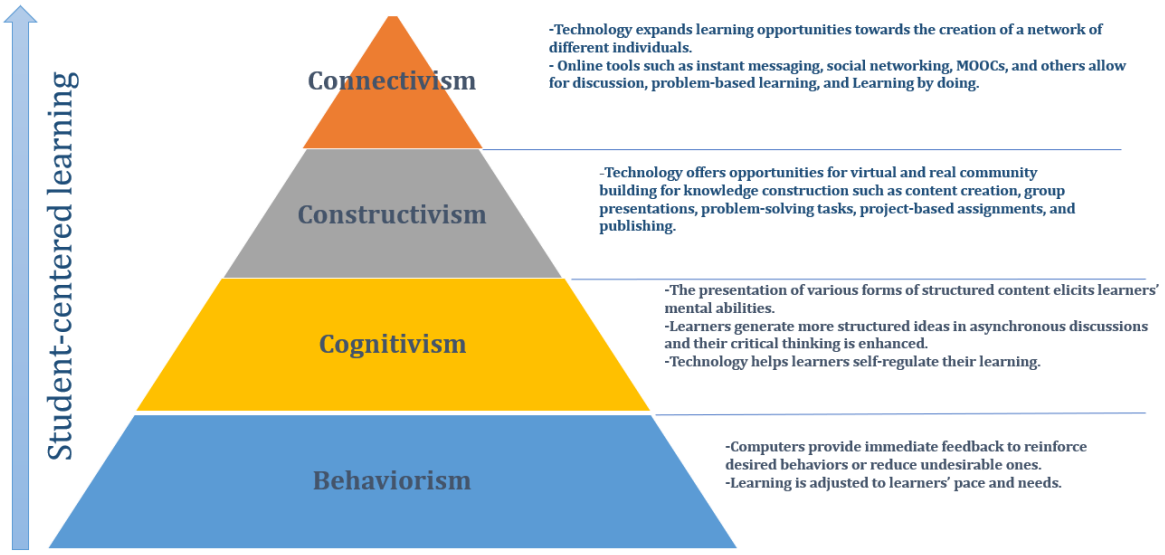


Fig. 2. The Pedagogical framework framing the use of ICT tools

Fig. 2 classifies the four learning theories in a pyramid in ascending order from less to more student-centred learning. The theory of behaviourism is placed at the bottom due to the limited learning opportunities it allows for. The behaviourist online environment enables learners to adjust their learning according to their pace and needs. Still, it only involves them as active agents who can participate with their knowledge and experiences. Besides, teachers' role is even narrower than in the traditional behaviourist learning environment as it remains limited to automatic stimulus-response associations. For instance, teachers facilitate and guide learners in choosing and completing interactive online exercises, and they are not allowed to guide learners toward interaction, collaboration, and knowledge construction.

The theory of cognitivism follows as it expands online learning a little further. The multiple forms of structured content in the online learning environment elicit learners' mental abilities to enhance their critical thinking skills and information processing. Not only do the numerous ICT tools such as forums, wikis, blogs, and online discussions stimulate learners' cognitive processes to organise, store and retrieve information, but they also provide them with new opportunities for collaboration, peer-editing, electronic publishing, and others with

no risks of cognitive load. Ref. [35] claim that ICT tools like audio-visual material and virtual reality lower individual cognitive load. Thus, the online cognitivist environment slightly drives learning towards a more student-centred approach.

The theory of constructivism expands the student-centred approach to learning due to the numerous online tools through which learners present information, collaborate with other learners, and participate in discussions and peer assessment. The aim is to reach autonomy since technology enhances learners' understanding, especially the virtual reality systems, which create sensory-rich interactive learning environments, as stated in [46], while allowing for multiple forms of communication [49].

The theory of connectivism is placed at the top of the pyramid since the student-centred approach to learning peaked. According to the four fundamental principles of connectivism identified by Ref. [22], autonomy, diversity, openness, and interactivity, they are widely expanded online. Learners reach a high level of autonomy as they take ownership of their learning and are open to different learning experiences. Besides, they interact with diverse communities from different backgrounds. The connective learning environment is the richest in the quantity and the quality of learning experiences as it focuses on the external dimension of learning, characterised by multiple forms of information and communication.

Conclusion

Because of the COVID-19 pandemic, the new paradigm in education has been adopted in educational systems worldwide at an unprecedented speed, even though its features were apparent long before the pandemic. As a significant technological revolution characterises it, the new paradigm in education necessitates a shift in teachers' perceptions of their technology-supported pedagogical knowledge. Thus, the paper aims to direct teachers towards the alignment of pedagogical principles with the technology-enhanced-learning environment so that they can develop effective, innovative teaching practices and adopt emerging pedagogies that call for student-centred learning, critical thinking, learners' pace of learning, collaborative learning, self-directed learning, and learning by doing. For this purpose, the four major learning theories, behaviourism, cognitivism, constructivism, and connectivism, are discussed in the online environment to assist teachers in the use of new technology. As for emerging pedagogies of the twenty-first century, they are highlighted within each learning theory. The developed pedagogical framework in the present paper aims to increase teachers' awareness of the necessity of enhancing the alignment between pedagogy and technology to deliver high-quality teaching based on a solid pedagogical foundation and best practice research.

Even though the four learning theories are introduced in ascending order in the proposed pedagogical framework in this paper, they complement each other as they examine learning from different perspectives. Thus, pedagogical practices should be based on appropriate learning theories according to lesson objectives and learning outcomes. For instance, educators can resort to behaviourism to practice skills, cognitivism to elicit and reinforce mental processes, constructivism to guide learners toward the construction of knowledge, and connectivism to expose learners to complex networks of individuals and online experiences.

Conflict of Interest

The author declares that there is no conflict of interest.

References

[1] Aburezeq, I. M., Ishtaiwa-Dweikat, F. F., & Patronis, M. [2020]. Behavioral Intention to Use Mobile Technology in Language Teaching: A Qualitative Analysis of a UAE Case Study. International Journal of Technology and Human Interaction, 16[4], 14-34. https://doi.org/10.4018/IJTHI.2020100102

[2] Agbatogun, A. O. [2014]. Improving communicative competence with 'clickers': acceptance/attitudes among Nigerian primary school teachers. Education 3-13, 42[1], 39-53. https://doi.org/10.1080/03004279.2011.637942

[3] Cox, M. [2003]. The effects of attitudes, pedagogical practices and teachers' roles on the incorporation of ICT into the school curriculum. Information and Communication Technology and the Teacher of the Future, 132, 145-158. https://doi.org/10.1007/978-0-387-35701-0_16

[4] Demetriadis, S., Barbas, A., Molohides, A., Palaigeorgiou, G., Psillos, D., Vlahavas, I., et al. [2003]. "Cultures in negotiation": teachers' acceptance/resistance attitudes considering the infusion of technology into schools. Computers & Education, 41[1], 19-37. https://doi.org/10.1016/S0360-1315[03]00012-5

[5] Kao, C. P., Wu, Y. T., Chang, Y. Y., Chien, H. M., & Mou, T. Y. [2020]. Understanding Web-Based Professional Development in Education: The Role of Attitudes and Self-efficacy in Predicting Teachers' Technology-Teaching Integration. Asia-Pacific Education Researcher, 29[5], 405-415. https://doi.org/10.1007/s40299-019-00493-x

[6] Perkins, R., & McKnight, M. L. [2005]. Teachers' attitudes toward WebQuests as a method of teaching. Computers in the Schools, 22[1-2], 123-133. https://doi.org/10.1300/J025v22n01_11

[7] Sofronova, N. V. [1995]. TEACHERS ATTITUDES TOWARD THE USE OF NEW INFORMATION TECHNOLOGIES. Russian Education and Society, 37[2], 5-9. https://doi.org/10.2753/RES1060-939337025

[8] Teo, T., Luan, W. S., & Sing, C. C. [2008]. A cross-cultural examination of the intention to use technology between Singaporean and Malaysian pre-service teachers: An application of the Technology Acceptance Model [TAM]. Educational Technology & Society, 11[4], 265-280.

[9] Cutri, R. M., Mena, J., & Whiting, E. F. [2020]. Faculty readiness for online crisis teaching: transitioning to online teaching during the COVID-19 pandemic. European Journal of Teacher Education, 43[4], 523-541. https://doi.org/10.1080/02619768.2020.1815702

[10] Mechlova, E., & Malcik, M. [2012, Nov 08-09]. ICT in Changes of Learning Theories. Paper presented at the 10th IEEE International Conference on Emerging eLearning Technologies and Applications [ICETA], Stara Lesna, SLOVAKIA. https://doi.org/10.1109/ICETA.2012.6418326

[11] McSweeney, F. K., & Murphy, E. S. [2014]. The Wiley Blackwell handbook of operant and classical conditioning: John Wiley & Sons. https://doi.org/10.1002/9781118468135

[12] Tolman, E. C. (1948). Cognitive maps in rats and men. Psychological review, 55(4), 189. https://doi.org/10.1037/h0061626

[13] Gagne, R. M. [1970]. The conditions of learning: Holt, Rinehart and Winston. https://eduq.info/xmlui/handle/11515/12803

[14] Piaget, J. [1964]. Development and learning, part 1 of cognitive development in children. Journal of Research in Science Teaching, 2[3], 176-186. https://doi.org/10.1002/tea.3660020306
[15] Vygotsky, L. S., & Cole, M. (1978). Mind in society: Development of higher psychological processes: Harvard university press. https://rb.gy/zft3me
[16] Bruner J. S. [1973]. Organization of early skilled action. Child Development 1–11. https://doi.org/10.2307/1127671
[17] Dewey, J. [1916]. Democracy and education by John Dewey. Project Gutenberg. https://www.fulltextarchive.com/pdfs/Democracy-and-Education.pdf
[18] Kanselaar, G. [2002]. Constructivism and socio-constructivism. Constructivism and socio-constructivism, 1-7. https://rb.gy/rez79e
[19] Piaget, J. [1977]. The development of thought: Equilibration of cognitive structures. [Trans A. Rosin]: Viking. https://doi.org/10.3102/0013189X007011018
[20] Hammad, R., Khan, Z., Safieddine, F., & Ahmed, A. [2020]. A review of learning theories and models underpinning technology-enhanced learning artefacts. World Journal of Science, Technology and Sustainable Development. https://doi.org/10.1108/WJSTSD-06-2020-0062
[21] Siemens, G. [2005]. Elearnspace. Connectivism: A learning theory for the digital age. Elearnspace. org. http://www.itdl.org/Journal/Jan_05/article01.htm
[22] Downes, S. [2012]. Connectivism and connective knowledge: Essays on meaning and learning networks. https://edtechbooks.org/connectivism
[23] Tschofen, C., & Mackness, J. (2012). Connectivism and dimensions of individual experience. International Review of Research in Open and Distributed Learning, 13(1), 124-143. https://doi.org/10.19173/irrodl.v13i1.1143
[24] Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. [2010]. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. Int J Surg, 8[5], 336-341. https://doi.org/10.1016/j.ijsu.2010.02.007
[25] Nishikawa-Pacher, A. Research Questions with PICO: A Universal Mnemonic. Publications 2022, 10, 21. https://doi.org/10.3390/publications10030021
[26] Lin P.-C. Hou H.-T. Wu S.-Y. & Chang K.-E. [2014]. Exploring college students' cognitive processing patterns during a collaborative problem-solving teaching activity integrating facebook discussion and simulation tools. The Internet and Higher Education 51–56. https://doi.org/10.1016/j.iheduc.2014.05.001
[27] Madani, K., Pierce, T. W., & Mirchi, A. [2017]. Serious games on environmental management. Sustainable Cities and Society, 29, 1-11. https://doi.org/10.1016/j.scs.2016.11.007
[28] Bose, S. [2018], Unit-3 Learning Theories: Implications for ICT. New Delhi: Indira Gandhi National Open University. http://egyankosh.ac.in//handle/123456789/46298
[29] Fegely A. G. Hagan H. N. & Warriner G. H. [2020]. A practitioner framework for blended learning classroom inquiry-based virtual reality lessons. E-Learning and Digital Media 521–540. https://doi.org/10.1177/2042753020926948
[30] Lage, M. J., Platt, G. J., & Treglia, M. [2000]. Inverting the Classroom: A Gateway to Creating an Inclusive Learning Environment. The Journal of Economic Education, 31[1], 30-43. https://doi.org/10.2307/1183338 https://doi.org/10.1080/00220480009596759
[31] Saks, K., & Leijen, Ä. [2014]. Distinguishing self-directed and self-regulated learning and measuring them in the e-learning context. Procedia-Social and Behavioral Sciences, 112, 190-198. https://doi.org/10.1016/j.sbspro.2014.01.1155
[32] Sahin Kizil A. & Savran Z. [2016]. Self-regulated learning in the digital age: an efl perspective. Novitas-Royal [Research on Youth and Language] 147–158.
[33] Gabriele, L., Marocco, D., Bertacchini, F., Pantano, P., & Bilotta, E. [2017]. An Educational Robotics Lab to Investigate Cognitive Strategies and to Foster Learning in an Arts and Humanities Course Degree. International Journal of Online Engineering, 13[4]. https://doi.org/10.3991/ijoe.v13i04.6962
[34] Consoli, D. [2013]. The implementation of a university 2.0 model Social Media in Higher Education: Teaching in Web 2.0 [pp. 1-23]: IGI Global. https://doi.org/10.4018/978-1-4666-2970-7.ch001
[35] Haryana M. R. A. Warsono S. Achjari D. & Nahartyo E. [2022]. Virtual reality learning media with innovative learning materials to enhance individual learning outcomes based on cognitive load theory. The International Journal of Management Education. https://doi.org/10.1016/j.ijme.2022.100657

[36] Leask, M., & Younie, S. [2001]. Communal constructivist theory: information and communications technology pedagogy and internationalisation of the curriculum. Journal of Information Techology for Teacher Education, 10[1-2], 117-134. https://doi.org/10.1080/14759390100200106
[37] Bofill, L. [2013]. Constructivism and collaboration using Web 2.0 technology. Journal of Applied Learning Technology, 3[2], 31-37. https://rb.gy/ychupq
[38] De Wever, B., Keer, H. V., Schellens, T., & Valcke, M. [2010]. Roles as a structuring tool in online discussion groups: The differential impact of different roles on social knowledge construction. Computers in Human Behavior, 26[4], 516-523. https://doi.org/10.1016/j.chb.2009.08.008
[39] Turvey, K., & Hayler, M. (2017). Collaboration and personalisation in teacher education; the case of blogging. Teaching and Teacher Education, 68, 42-52. https://doi.org/10.1016/j.tate.2017.08.003
[40] Kala, S., Isaramalai, S.-a., & Pohthong, A. [2010]. Electronic learning and constructivism: A model for nursing education. Nurse Education Today, 30[1], 61-66. https://doi.org/10.1016/j.nedt.2009.06.002
[41] Alshumaimeri, Y. [2011]. The effects of wikis on foreign language students writing performance. Procedia - Social and Behavioral Sciences, 28, 755-763. https://doi.org/10.1016/j.sbspro.2011.11.139
[42] Jumaat, N. F., & Tasir, Z. [2013]. Integrating Project Based Learning Environment into the Design and Development of Mobile Apps for Learning 2D-Animation. Procedia - Social and Behavioral Sciences, 103, 526-533. https://doi.org/10.1016/j.sbspro.2013.10.369
[43] Denton, D. W. [2012]. Enhancing Instruction through Constructivism, Cooperative Learning, and Cloud Computing. TECHTRENDS, 56[4], 34-41. https://doi.org/10.1007/s11528-012-0585-1
[44] Gielen, M., & De Wever, B. [2012]. Peer Assessment in a Wiki: Product Improvement, Students' Learning And Perception Regarding Peer Feedback. Procedia - Social and Behavioral Sciences, 69, 585-594. https://doi.org/10.1016/j.sbspro.2012.11.450
[45] Gilakjani, A. P., Leong, L.-M., & Ismail, H. N. [2013]. Teachers' Use of Technology and Constructivism. International Journal of Modern Education & Computer Science, 5[4]. https://doi.org/10.5815/ijmecs.2013.04.07
[46] Onyesolu, M. O., Nwasor, V. C., Ositanwosu, O. E., & Iwegbuna, O. N. [2013]. Pedagogy: Instructivism to socio-constructivism through virtual reality. International Journal of Advanced Computer Science and Applications, 4[9].
[47] Wang, Y. C. (2014). Using wikis to facilitate interaction and collaboration among EFL learners: A social constructivist approach to language teaching. [Article]. System, 42(1), 383-390.
[48] Al-Abri, A., Jamoussi, Y., Kraiem, N., & Al-Khanjari, Z. [2017]. Comprehensive classification of collaboration approaches in E-learning. Telematics and Informatics, 34[6], 878-893. https://doi.org/10.1016/j.tele.2016.08.006
[49] Scavarelli A. Arya A. & Teather R. J. [2020]. Virtual reality and augmented reality in social learning spaces: a literature review. Virtual Reality 257–277. https://doi.org/10.1007/s10055-020-00444-8
[50] Corbett, F., & Spinello, E. [2020]. Connectivism and leadership: harnessing a learning theory for the digital age to redefine leadership in the twenty-first century. Heliyon, 6[1], e03250. https://doi.org/10.1016/j.heliyon.2020.e03250

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