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Faculty's Pedagogical Knowledge for Technology-Enhanced Learning in Higher Education

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ABSTRACT

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

Keywords: review, technology-enhanced learning, pedagogy, learning theories

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1. Introduction

All over the world, COVID-19 pandemic has led to abrupt new challenges in higher education institutions as it has established a significant paradigm shift in teaching and learning. The overwhelming urge toward distance education, as a result of the closure of Universities and colleges, hastened the use of technology by teachers 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 (See e.g., Aburezeq et al., 2020; Agbatogun, 2014; Cox, 2003; Demetriadis et al., 2003; Kao zt al., 2020; Perkins & McKnight, 2005; Sofronova, 1995; Teo et al., 2008). It can be noticed that the context of emergency online teaching during the pandemic altered the normal 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 (Cutri, Mena, & Whiting, 2020). As a result, e-learning has flourished despite the social, economic, political, and psychological disruptions of the pandemic. 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 both 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 practices are based on learning theories, the purpose of this paper is to examine how the principles of the four learning theories; behaviorism, 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; behaviorism, cognitivism, constructivism, and connectivism in relation to the online environment. Then, the emerging pedagogies; critical thinking, student-centered 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 of higher education 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.

2. Literature review

2.1. The pandemic of COVID-19 and the challenging use of ICT

The massive growth of e-learning as a result of the pandemic unveiled several difficulties and challenges regarding educational practices especially since educators had to adapt to an abrupt new learning mode in a very short time. Some problems that are encountered by educators in Turkey across K-12 and university levels, for instance, concern assessment, evaluation, lack of teacher-student interaction, unfulfilled learning outcomes, feedback transmission, and lack of motivation (Korkmaz & Toraman, 2020). In addition to these pedagogical issues which involve the need for the digital transformation of instructional activities, Adedoyin & Soykan (2020) refer to digital literacy, the acquisition of ICT skills, as an inhibiting factor affecting the migration of faculty members into remote teaching. In India, Dhawan (2020) conducts a SWOC (Strengths, Weaknesses, Opportunities, and Challenges) analysis of the e-learning mode during the pandemic in schools, colleges, and universities. Strengths of online learning during the pandemic in India are referred to as time and location flexibility, availability of content, and immediate feedback. Opportunities are identified as digital development and skills reinforcement, whereas weaknesses encompass technical difficulties, lack of direct communication, learners' capability and seriousness level, distraction, anxiety, time management, and lack of attention. As for Challenges, they include educators' and content issues, students' engagement, quality control, unequal distribution of ICT infrastructure, digital illiteracy, and digital divide. It can be noticed that the SWOC analysis refers to digital skills as a weakness and also as a challenge. The reason is that digital literacy is the most challenging factor facing the use of ICT.

Even though Jena (2020) reacts positively to the impacts of COVID-19 on higher education due to the availability of various educational services, he stresses the need for training of both teachers and learners in the utilization of online tools. Besides, other suggestions are made about quality assurance matters, assessment, the availability of infrastructure, and virtual educational resources. While discussing university responses to COVID-19 across 20 countries, Crawford et al. (2020) highlight several difficulties regarding the transition from face-to-face to online learning in higher education. For instance, they refer to the lack of resources or academic competencies in China, the need for effective all-inclusive online courses in Jordan, and non-strategic moves to online teaching in the United Arab Emirates. As

for countries closer to China except for Malaysia, South Korea, and Indonesia, the paper acknowledges their ownership of a digital strategy in higher education despite the need for infrastructure and pedagogy for online content design. Even though most Swedish schools at different levels of education use different digital products during the pandemic and despite their possession of digital agendas (The European Commission (2019, as cited in Bergdahl & Nouri, 2020), there are still many technological and pedagogical issues that schools fail to tackle especially that the crisis required new teaching and learning practices. Examples of these issues are unstable applications or connections, lack of secure digital examination tools, or personalized communication tools for particular pedagogical activities. The transition to the online environment during the pandemic was indeed very challenging in terms of technology and pedagogy. Yet, technology-enhanced learning environments expand educational opportunities for innovative teaching and learning.

2.2. The technology-enhanced learning environment in higher education during COVID-19

Despite the complex transition from traditional teaching into remote instruction, the online environment could ensure pedagogical continuity in higher education institutions. In a work-integrated learning postgraduate course in health care at the University of Tasmania in Australia, for instance, the online environment enabled the creation of flexible virtual projects tailored according to students' needs, experiences, and interests regardless of the challenges faced during COVID-19. These virtual projects also encouraged creativity, critical thinking, and adaptation to different learning styles (Prior et al., 2020). In India, new modes of learning have emerged in higher educational institutions as a response to the crisis during the pandemic. Virtual platforms with online depositories like e-books and other teaching and learning materials were launched, in addition to social media tools, online platforms, a National Digital Repository, a web-based TV channel, a web radio which is an audio counseling service, Massive Open Online Courses, the National Digital library which is a repository of a wide e-content, virtual labs for remote operation, etc (Jena, 2020).

More than that, faculty members developed online teaching content such as PowerPoint presentations, recorded video lessons, and audio teaching materials to be shared on the aforementioned platforms. More than this, Indian teachers became experts in online teaching using several social media platforms to engage students academically and mentally (Dutta, 2020). In Sweden, both synchronous and asynchronous teachings were used by teachers of different levels of education. While a considerable number of teachers planned for synchronous teaching with teacher-led lessons, peer-to-peer interaction, oral instructions, and feedback, others resorted to asynchronous teaching which focused more on written instruction and asynchronous submission with no interaction. For that purpose, teachers used digital tools such as Zoom, Google Hangout, and Microsoft Teams which allowed for the growth of these two types of teachings; synchronous and asynchronous (Bergdahl & Nouri, 2020). Since the invention of the World Wide Web, online education has been more and more accessible but not a compulsory requirement for educators and learners. During the pandemic, however, online education has become essential for pedagogical continuity and academic support. Therefore, the new paradigm in education requires the examination of the pedagogical potential of online technologies for the construction of effective meaningful online learning experiences. Some expert advice concerning the adaptation to online learning and teaching is referred to as "pedagogisation rather than digitalization of higher education" (Rapanta et al., 2021, p. 715).

2.3. Learning theories

While the purpose of this paper is not to 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.

2.3.1. Behaviorism

In Behaviorism, learning occurs as a result of observable external behavior in sequences of stimulus-response relationships (Mechlova & Malcik, 2012). 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 type of learning that associates the behavior with consequences; rewards and punishments (McSweeney & Murphy, 2014). According to Mechlova & Malcik (2012), this behaviorist perspective is relevant to instructional practices which are characterized by systematic design, performance objectives, competency-based instruction, and the instructor's responsibility to prompt desired behaviors and dampen undesirable ones.

2.3.2. Cognitivism

Away from behaviorism, cognitivism views learning as a cognitive process whereby learners make use of their mental abilities to process information (Tolman, 1948; Gagne, 1970; Piaget, 1964; Vygotsky & Cole, 1978; Bruner, 1973). Gestalt learning theories claim that learning is achieved through perception, insight, and meaning since individual learners are involved in the processes of organization and interpretation of meaningful experiences. Piaget (1964) raises the issue of developmental changes in the nervous system which occur as a result of various learning experiences and environments. Unlike behaviorism which explains learning through stimulus-response associations and drilling, cognitivism views learners as individual beings who are equipped with a mental capacity to deal with content by means of organization, reasoning, categorization, coding, transferring, etc.

2.3.3. Constructivism

According to the theory of constructivism, learners construct knowledge through their involvement in the learning process (Dewey, 1916). Kanselaar (2002) refers to two major constructivist perspectives; cognitive constructivism and the socio-constructivist perspective. Cognitive constructivism is based on the work of Piaget (1977) who claims that learners develop their cognitive abilities either through assimilation or accommodation. Assimilation is when learners associate new information with what they already know in an attempt to assimilate it to their already existing knowledge, whereas 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, Vygotsky & Cole (1978) recognize 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 the preservation of its intrinsic collaborative character (Kanselaar, 2002). In addition, Tangney et al. (2001) explore the approach of communal constructivism "in which students not only construct their own knowledge (constructivism) as a result of interacting with their environment (social constructivism) but are also actively engaged in the process of constructing knowledge for their learning community" (p.1).

2.3.4. Connectivism

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 (Hammad et al., 2020). Learning theories fail to recognize the external dimension of learning as it is guided by technology and how it happens within organizations (Siemens, 2005). Therefore, connectivism is introduced as an alternative learning theory that connects learning not only to diverse opinions and interaction between specialized communities or information sources but also to 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" (Siemens, 2005, p. 6). To create a reliable network, Downes (2012) identifies four key principles; autonomy, diversity, openness, and interactivity. Autonomy recognizes individuals as independent entities who can act independently, make choices, and minimize external control. As for diversity, individuals' distinct characteristics such as race, gender, and socioeconomic status are acknowledged. The connectivist environment is also open in terms of receiving and sharing external output like communication, expertise, ideas, resources, and insights through a process of interactivity and connectedness (Tschofen & Mackness, 2012).

3. Method

3.1. 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: ("behaviorism and the online environment" OR "behaviorism 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 at a rapid pace. Yet, other relevant classic studies were also selected.

3.2. Selection process and criteria

This review uses an explicit method to identify, select, assess, and analyze 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 articles (Moher et al., 2010). As it is demonstrated in Figure 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 summarized to examine their eligibility for inclusion (Table 1). The articles that did not meet the inclusion criteria were

eliminated (n=59) as well as the ones which overlapped. The total number of studies that were finally selected for the qualitative analysis is (n= 27). Figure 1 demonstrates the different phases of a systematic review.

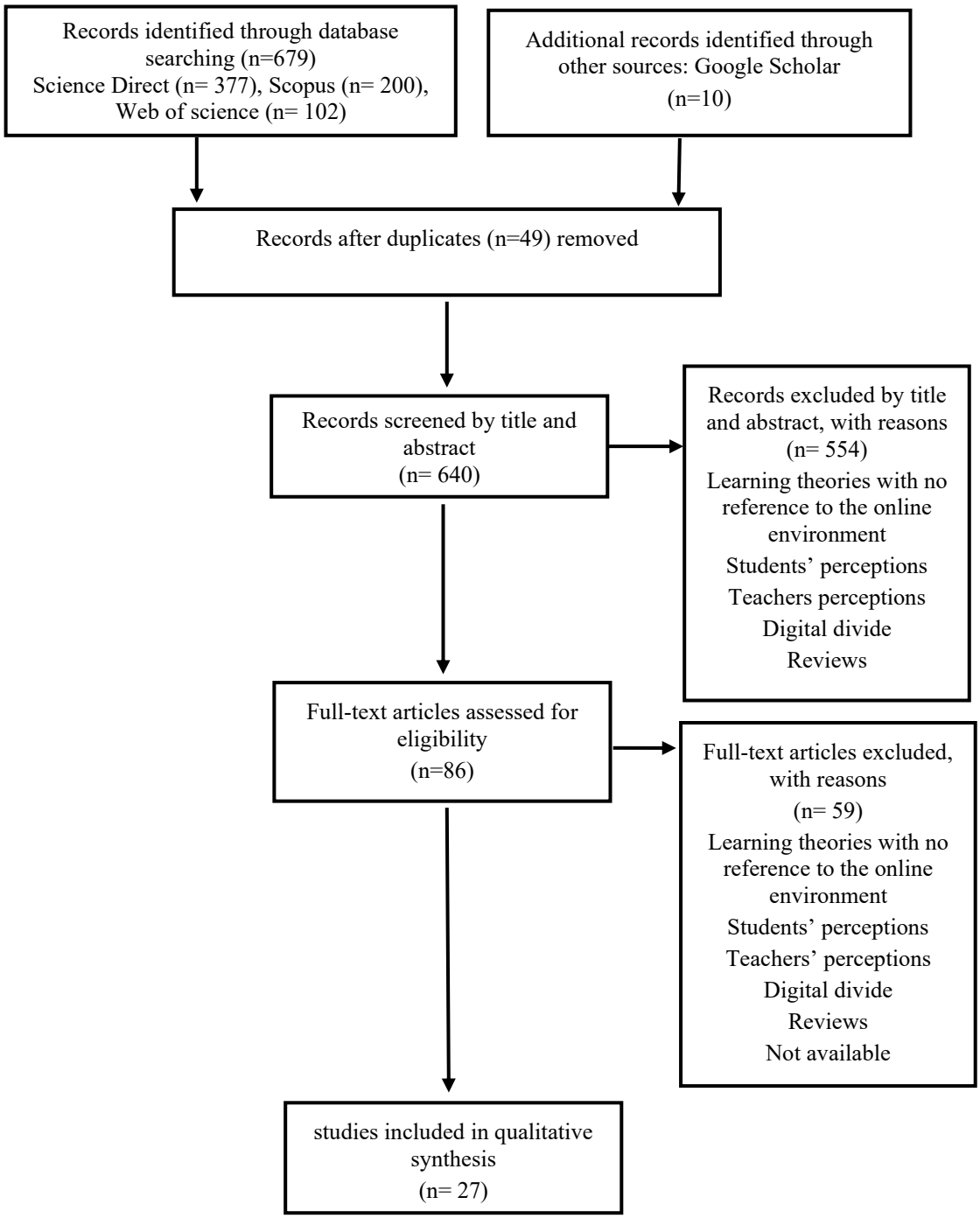

Figure 1. The flow of information through the different phases of a systematic review
Source (Adapted from Moher et al., 2010)

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

3.3. Data analysis

Data was extracted from the retrieved literature and analyzed according to this paper's research questions. The key criteria for paper selection are as follows: the four learning theories, behaviorism, cognitivism, constructivism and connectivism, the online environment, and pedagogical models. Then, the PICO framework; Problem, Intervention, Comparison, and Outcome is 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 (Nishikawa-Patcher, 2022). 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: (Nichikawa- Patcher, 2022, p. 4)

The first component of the framework is 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 the implementation of the aforementioned research objects 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.

4. Findings

Table 3 presents the results obtained from the selected studies. The PICO framework details them in terms of the research object; the four learning theories and pedagogical models. The implementation of these research objects in the online environment is highlighted. Then, the comparison between the research objects to others or to 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

N°	Author	Problem	Intervention	Comparison	Outcome
1	Lin et al. (2014)	-College students' cognitive processing patterns in a collaborative-problem-solving teaching activity integrating Facebook discussion tools and simulation-based teaching software.	-45 students took an online course aimed to teach basic networking concepts and to develop students' network troubleshooting abilities. -Quantitative analysis content is used to code the -online discussions and explore the cognitive levels. -A lag sequential analysis was conducted to analyze the coding results of the analysis and assess the behavioral patterns during the discussion process. -A pre-test and a post-test are administered.	-Relationship btw cognitive abilities and collaborative construction of knowledge.	-Students' network troubleshooting abilities improved. -There are differences in sequential cognitive processing between "discussion-centered" and "manipulation-centered" groups.
2	Madani et al. (2017)	-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., behaviorism, 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 lack quantitative results. -GBL increases students' motivation and engagement.
3	Bose (2018)	-Learning theories and the online environment.	-The implications of learning theories for ICT use.	-The implication of behaviorism, 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.

N°	Author	Problem	Intervention	Comparison	Outcome
4	Fegely, Hagan & Warriner (2020)	-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.
5	Hammad et al. (2020)	-In the technology-enhanced learning domain, there is a missing balance between technology and pedagogy.	-Qualitative analysis of the most influential pedagogical theories, models, and frameworks.	-The comparison of learning theories and frameworks and the presentation f the special aspects of each one.	-Learning theories are classified into three perspectives: associationist, cognitive, and situative. -Learning theories complement rather than compete with each other.
6	Lage, M. J., Platt, G. J., & Treglia, M. (2000)	-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 power point presentations, web-sites, video and sound files facilitate the implementation of the inverted classroom.
7	Sacks & Leijen (2014)	-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 the way self-directed learning and self-regulated learning are understood and described. SDL and SRL are used as synonyms.
8	Sahin Kizil & Savran (2016)	-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 are actively engaged in the use of ICT tools for self-regulated language learning.	-EFL learners were actively engaged in the use of 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, level. And needs. -Yet, EFL learners do not use ICT for

N°	Author	Problem	Intervention	Comparison	Outcome
					metacognitive and social regulation and there were variations among learners and in aspects of regulating learning through the use of ICT tools.
9	Gabriele et al. (2017)	-Cognitive strategies of arts and humanities students when learning different Robotics concepts.	-The investigation of students' cognitive abilities while using a Robotics Serious Game through a pre and a post-test on motivation and Project Based Learning (PBL) methodology.	-Compared to the traditional learning environment, the robotic lab simulates students' motivation and engagement in learning.	--Cognitive activities in the educational robotics lab stimulate students' motivation, curiosity, and interest.
10	Consoli (2013)	-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 less innovative pedagogical opportunities in instruction and research.	-The University 2.0 model brings best practices to support teaching and research.
11	Haryana et al. (2022)	-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 the field of accounting. -This study manipulated the experimental group in the form of learning media (audio-visual and virtual reality) and accounting equation learning materials (traditional and nontraditional).	-Unlike VR and audio-visual material, traditional learning materials involve learners in the processes of memorization or the formation of new schemes to understand new knowledge. This working memory utilization is not optimal.	-Individual learning performance and outcomes were higher when using VR. VR and non-traditional learning materials lower individuals' cognitive load.
12	Leask & Youni (2001)	-Communal constructivist theory and ICT pedagogy.	-The exploration of communal constructivism in several international ICT projects.	-In the absence of ICT, there are less opportunities for collaborative creation of knowledge, especially in the absence of online publishing tools and virtual community building.	-Various forms of ICT are effective. -They bring new opportunities to learning such as virtual and real community building. -New pedagogical practices arise such as the collaborative construction of knowledge.
13	Bofill (2013)	-Constructivism and web 2.0 technologies to enhance collaboration.	-The development of 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 less opportunities of	-The instructional lesson design model guided lesson plan development. -Technology provided

N°	Author	Problem	Intervention	Comparison	Outcome
				collaboration for students.	opportunities of collaboration.
14	De Wever et al. (2010)	-Social knowledge construction in e-discussions through roles assignment.	-Asynchronous discussion groups of 10 first-year students in instructional sciences were organized to help students in the processing of the learning content.	-Without synchronous discussion groups, there are constraints of time, place, and access. -In classroom discussions, students do not have enough time to retain role-related activities.	-Knowledge construction reaches higher levels due to role assignment. -Role assignment in the long run (e-discussions) allows students to have more time to internalize role-related activities.
15	Turvey & Hayler (2017)	-The potential of blogging amongst pre-service teachers' professional learning.	-Narrative methodology involving the analysis of participants' stories.	-Without the digital blogging space, there are fewer opportunities for pre-service teachers to collaborate and personalize their teaching experiences.	-The blogging space led to the collaboration of pre-service teachers to discuss their professional demands and pedagogical experiences to personalize their teaching profession.
16	Kala et al. (2010)	-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	Alshumaimeri (2011)	-The effects of wikis on foreign language students' writing.	-Pre-tests and post-tests 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	Jumaat & Tasir (2013)	-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 the creation and development of 2D animation tools and the creation of multimedia courseware applications.	-Without PBL, learners have less control over their learning process.	-Through the integration of project-based learning in the design and development of the apps, learners have more control over their learning process.
19	Denton (2012)	-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 the use of cloud computing technologies to enhance their understanding of assessment and instruction through content publishing, simultaneous written activities and collaboration in various activities.

N°	Author	Problem	Intervention	Comparison	Outcome
20	Gielen & De Wever (2012)	-Peer assessment in a computer-supported collaborative learning environment (wiki) in higher education	-Involving 2 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 (behaviorism, cognitivism, and constructivism) over a period of 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 quality of the initial work and the quality of the final product. 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 giving and receiving profound and detailed feedback. profound
21	Gilakjani et al., (2013)	-Constructivism and the use of technology	-The examination of the theory of constructivism and the factors contributing to the effective use of technology.	-Traditional teaching approaches do not use technology effectively.	-Constructivism is an appropriate framework for educational technology.
22	Onyesolu et al. (2013)	-Instructivism and socio-constructivism 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 a virtual surrounding.	-The VR system enhanced students' understanding through the creation of a sensory-rich interactive learning environment.
23	Wang (2014)	-Wikis in an EFL writing classroom to facilitate collaboration and promote foreign language acquisition through a social constructivist perspective.	-Two online questionnaires and interviews are conducted with 42 students on their reflections on using wikis for collaborative writing.	-Due to its collaborative and interactive nature, a wiki is more related to the constructivist approach than to other learning approaches.	-Wikis increase the students' 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 both language development and social interaction.
24	Al Abri et al. (2017)	-Collaborative approaches in e-learning.	-State-of-art in 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

N°	Author	Problem	Intervention	Comparison	Outcome
					asynchronous communication, and they all promote collaborative learning.
25	Scavarelli, Arya, and Teather (2020)	-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 processes of learning 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. VR /AR learning depends on constructivism, experiential learning, social cognitive theory and activity theory.
26	Gorbett & Spinello (2020)	-The theory of connectivism and leadership.	-A review of the theory of connectivism in terms of 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 characterized by dynamism, connectivity, and collectivity as it is rooted in digital knowledge and interpersonal networks.
27	Tschofen & Macknes (2012)	-Individual experience in connective environment.	-The expansion of four key principles of connectivism to recognize 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.

5. Discussion

Even though learning theories were developed long before the emergence of new technologies in education, they are essential for the creation of all learning environments as they guide pedagogy. Since instruction in the majority of today's classes is "based on traditional learning theories where technology is being used only as a tool in replacement of traditional tools" (Gilakjani et al., 2013, p.57), optimum use of technology should be based on pedagogy to make learners either consumers of information or collective creators of knowledge (Bose, 2018). A study about serious environmental management games refers to the need for the improvement of game design and its implementation by educators to accompany technological advancement. The focus should, therefore, be on pedagogical learning theories and learning principles like motivation, cognition, and socialization to enhance students' cognitive skills, critical thinking,

problem-solving, teamwork, etc (Madani et al., 2017). This review focuses on how each theory of learning is shaped in the online environment in a way that ICT tools offer alternative options and pedagogical models for innovative educational practices along with the accomplishment of the principles of learning theories.

5.1. Behaviorism

Some computer-assisted instructions are based on behaviorist online environments as they provide immediate feedback to either reinforce true responses or reject false ones. Bose (2018) refers to examples like games on computers or mobile phones which provide feedback about 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 several 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 particular 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 behaviorist 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 (Lage et al., 2000). Besides, technology-enhanced student-centered learning environments enable students to adjust the learning process according to their own pace and needs. In some interactive exercises, for instance, learners are given the possibility to modify or adjust their previous answers. They are also provided with some hints which assist them either before or after the accomplishment of tasks. Concerning teachers' roles, the behaviorist learning model does not expand it to the level of guiding, monitoring, and facilitating the learning process. When teachers are required to assist students in self-correction exercises and drilling practice, for example, they are limited in terms of support and assistance provided to students. Thus, teachers are not drifted away from their traditional roles based on information delivery, receptiveness, and control. In the case of interactive exercises based on mechanical associations, it is true the teacher is no more the source of information since students rely more on computers to either reinforce or reject their answers. However, the learning environment remains mechanical and does not broaden the learning experience as well as the teacher's role. In addition to these behaviorist principles of learning, it is also important to explore learners' internal mental processes which enable another form of learning to take place.

5.2. Cognitivism

In the context of online instructional environments, technology has the potential to elicit learners' mental abilities through the presentation of logically sequenced structured content, summaries, examples, analogies, concept maps, etc., to facilitate information processing and promote critical thinking (Bose, 2018). An example is the writing skill which can be exploited more effectively in the online environment than in traditional face-to-face learning since teachers can enhance collaboration among students, 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 it is confirmed in a study exploring the effect of wikis on writing skills during the Preparatory Year (PY) at King Saud University in Saudi Arabia (Alshumaimeri, 2011). In addition to synchronous class discussions taking place in both physical and online classes, the online environment offers other opportunities for asynchronous discussions in which students are more exposed to the content, and therefore, they have more time to generate more composed and thoughtful responses. Yet, online learning

may cause both cognitive overloading and disorientation. Hammad et al., (2020) refer to self-regulated learning to help in overcoming these difficulties through the acquisition of cognitive and meta-cognitive skills. Saks & Leijen (2014) refer to examples like the diagnosis of needs, learning goals formulation, resource identification and selection, learning strategies implementation, and learning outcomes evaluation. 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 regulate different aspects of their learning such as goal commitment regulation, affective regulation, and resources regulation thanks to the use of ICTs (Sahin Kizil & Savran, 2016). Respectively, learning results on an Educational Robotics Lab carried out with University students identify two main strategies: "1) Solution-focused strategy: Based on modifications of the evolutionary parameters over and over again (trials and errors); 2) Problem-focused strategy: Based on detailed analysis of the assigned task, taking into account the performance that the robot had to do" (Gabriele et al., 2017, p. 14). It can be noticed that the solution-focused strategy is based on behavior modification through trial and error, which is an aligned behaviorist technique operating on the concept of reinforcement. Bose (2018) explains that reinforcement through drill and practice is still important when learners aim for perfection and naturalization. This refers to the existing complementarity between the two aforementioned theories, behaviorism and cognitivism, as they both examine the learning process from different perspectives. Another 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 (Lin et al., 2014). 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.

5.3. Constructivism

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, internationalization of the curriculum, students as stakeholders of their learning, access to authentic and up-to-date knowledge, publishing students' quality products, etc (Leask & Younie, 2001), 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 (Bofill, 2013), in addition to publishing students' learning outputs either 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 certainly results in the improvement of the wiki product as it was confirmed in a study examining the added value of peer assessment in a computer-supported collaborative learning environment in higher education on the improvement of the wiki (Gielen & De Wever, 2012). Another study exploring the use of wikis in an EFL writing classroom referred to the increase in students' motivation, the enhancement of their writing confidence, the promotion of collaborative activities, and language development for social constructivist learning (Wang, 2014).

As for blogging, it yields a personalized 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 (Turvey & Hayler, 2017). 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, in addition to podcasting to allow for the sharing of media files. Other technological devices, such as MP3 players, iPhones, and Personal Digital Assistants were also used in e-learning courses (Kala et al., 2010), in addition to other cloud computing technologies such as Google Docs and Microsoft Office Live. These foster instructional methods based on the principles of constructivism and cooperative learning when they are used effectively by educators (Denton, 2012). 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 a process of knowledge construction to develop a course of action through social interaction with their peers. At the University of Technology in Malaysia, the integration of Project-Based Learning into the design and the development of mobile apps for learning 2D animations allowed for authentic learning experiences. Through the practice of their technical skills and the development of their product, students could construct their creativity. More than that, the learning environment enhanced cooperation among team members as they reflected together, exchanged feedback, gathered and discussed material (Jumaat & Tasir, 2013). It can be noticed that the aforementioned pedagogical models apply to the principles of cognitive constructivism and social constructivism since learners could develop both their cognitive abilities and social communication. As for teachers, they are in charge of managing students' performances and assisting them in the use of different technological tools. An example is a simulation of social knowledge construction in e-discussions by teachers through the assignment of roles to students; starter, summarizer, moderator, theoretician, and source searcher. De Wever et al. (2010) claim that role assignment has a positive impact on students' social construction of knowledge as it reaches higher levels. Besides, the impact of peer tutor regulation on knowledge construction was higher in online discussions due to its value in nurturing the processes of knowledge construction. ICT tools facilitate roles assignment for students such as editable content docs on Canvas, Google docs, or Microsoft Office 365. Other online scheduling tools help students collaborate to sign up for their roles in advance. More than this, technology allows for advanced technological experiences such as virtual reality learning environments. Thanks to a blended learning virtual reality inquiry framework designed by Fegely et al. (2020), learners are prepared for analytical, and active learning experiences while educators are guided in planning meaningful virtual reality learning experiences. Through these examples of technological tools and others, learners are enabled to perform roles, carry out tasks and identify with learning experiences. This means that the online environment adheres to the principle of learning by doing as it necessitates participation and involvement on the part of learners. Consoli (2013) links learning by doing to the theory of constructivism as they are both based on interaction, participation, and collaboration while constructing knowledge. Since the integration of technology in learning results in new learning opportunities and pedagogical models, the effects of technology on learning necessitate further examination.

5.4. Connectivism

The technology-based learning environment allows for the extension of the connectivist learning network as it alters and enriches how and what people learn. The plethora of opportunities offered through various technological tools strengthens learners' autonomy to make independent choices in a multitude of 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 stands as a rich external

environment where learners can perform tasks, combine and transform experiences. The development of Massive Open Online Courses (MOOCs) demonstrates the practical application of the aforementioned principles of connectivism as they were created to bring a large number of people together (Corbett & Spinello, 2020). Other types of services such as various instant messaging services and online collaboration tools and software help foster cooperation among learners. Al-Abri et al. (2017) clarify 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. Overall, "learning in connectivism terms is a network phenomenon, influenced, aided, and enhanced by socialization, technology, diversity, the strength of ties, and context of occurrence" (Tschofen & Mackness, 2012, p. 125).

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.

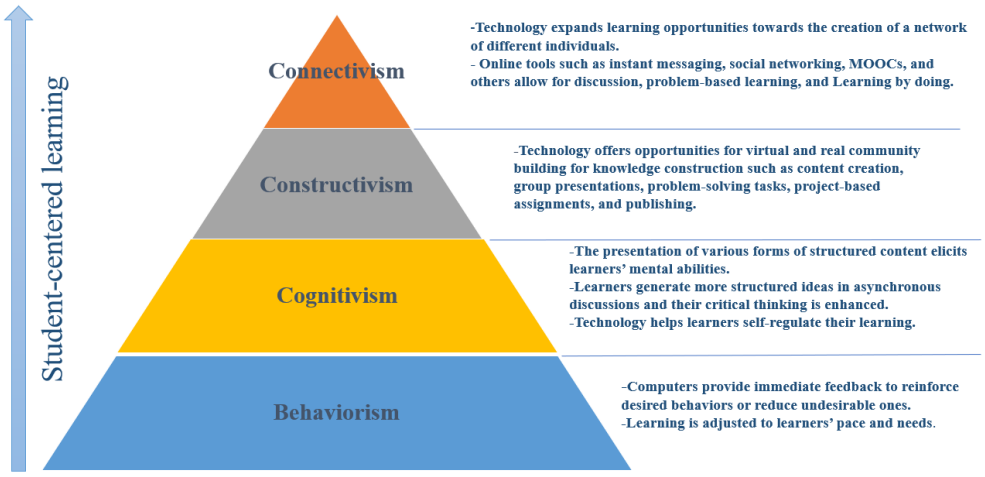

Figure 2: The Pedagogical framework framing the use of ICT tools

Figure 2 above classifies the four learning theories in a pyramid in ascending order from less to more student-centered learning. The theory of behaviorism is placed at the bottom due to the limited learning opportunities it allows for. It is true that the behaviorist online environment enables learners to adjust their learning according to their pace and needs, but it does not involve them as active agents who can participate with their knowledge and experiences. Besides, teachers' role is even narrower than in the traditional behaviorist learning environment as it remains limited to automatic stimulus-response associations. For instance, teachers facilitate and guide learners in the choice and completion of interactive online exercises only 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 organize, 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. Haryana et al. (2022) 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-centered approach.

The theory of constructivism expands the student-centered 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 a level of autonomy since technology enhances learners' understanding, especially the virtual reality systems which create sensory-rich interactive learning environments (Onyesolu et al., 2013) while allowing for multiple forms of communication to take place (Scavarelli et al., 2020).

The theory of connectivism is placed at the top of the pyramid since the student-centered approach to learning reaches its peak. According to the four key principles of connectivism identified by Downes (2012); autonomy, diversity, openness, and interactivity, they are widely expanded in the online environment. Learners reach a high level of autonomy as they take ownership of their learning, in addition to being open to different learning experiences. Besides, they interact with diverse communities from different backgrounds. The connectivist learning environment is the richest in terms of the quantity and the quality of learning experiences as it focuses on the external dimension of learning characterized by multiple forms of information and communication.

Despite the ascending order of the four learning theories, they do examine learning from different perspectives and should, therefore, complement each other to enrich the learning experience. Thus, pedagogical practices should be based on appropriate learning theories according to lesson objectives and learning outcomes. For instance, an educator can resort to behaviorism 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. It is worth mentioning that all these theories or some of them can be implemented in a single lesson through which learners are involved in multiple activities involving the practice of different skills before the attainment of the learning outcome.

6. Conclusion

Because of COVID-19 pandemic, the new paradigm in education has been adopted in educational systems all over the world at an unprecedented speed even though its features were apparent long before the pandemic. As it is characterized by a significant technological revolution, 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-centered learning, critical thinking, learners' pace of learning, collaborative learning, self-directed learning, and learning by doing. For this purpose, the four major learning theories; behaviorism, cognitivism, constructivism, and connectivism are discussed in relation to 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 theory of learning. 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. For better outcomes in educational spheres, teachers' ICT practices should undergo a continuous process of examination and investigation for further improvement of the quality of education.

Since the principles of the aforementioned learning theories are boosted in a technology-enhanced learning environment, teachers can increase learners' involvement in the learning process thanks to innovative ICT tools. Student-centered learning can, therefore, be easily

established in such a rich online learning environment where the learner's role is critical and central. Learners can make use of their cognitive abilities to practice and construct the learning process through social interactions with internal and external communities. So, this hybrid approach to learning is the result of complementary rather than opposing pedagogical approaches (Hammad et al., 2020). That is to say, pedagogical learning theories should not be implemented in isolation in the learning environment as they rather complement each other while catering for various skills' development.

7. Limitations and recommendations

The present paper has presented an overview of learning theories and their connection to the online environment based on a sample of the relevant literature. Yet, it did not present a deep analysis of the four learning theories which could have provided more insights into their implementation in the online learning environment. Besides, other learning theories could have been included to enrich the analysis of the paper and explore other pedagogical principles allowing for the construction of online learning opportunities. It has also been noticed that the studies exploring the principles of traditional learning theories in the online environment are limited. Further studies should, therefore, focus on this area to provide a solid pedagogical background for online learning teaching practices to flourish. More empirical studies should also be conducted to highlight best ICT practices and at the same time point at the limitations of digital technologies in education.

8. Implications for the higher education classroom

Teachers' pedagogical knowledge is highly required in the higher education classroom which does not necessarily prioritize pedagogy. As it is claimed by Endrizzi (2011), higher education seems to be solely preoccupied with the production of knowledge. This results in tensions and debates in the teaching profession in higher education which includes both research and teaching (Bruter, 2009). Since higher education is expected to deliver knowledge, skills, and information in different specialties, teaching pedagogy tends to be devalued or overlooked. More than that, learning how to teach remains a taboo for faculty who link teacher training to deprofessionalization rather than professionalization (Colet & Berthiaume, 2009).

With the emergence of technology in education, teachers cannot be exempted from pedagogical knowledge as they are required to adopt new pedagogical practices which require minimum knowledge of basic traditional pedagogical approaches. Moreover, new emerging pedagogies centered on learners characterize technology enhanced-learning environments as they enable enhanced forms of learners' autonomy, collaboration, communication, critical thinking, etc. For higher education to accomplish its mission of preparing the future workforce and developing the knowledge economy, learners need to be directed towards more collaboration and communication with external communities via virtual communication or collaboration tools to transfer knowledge, and intellectual abilities and at the same time acquire professional skills. This leads to more autonomy when learners undergo different experiences of information exchange, negotiation, and decision-making. Other ICT tools like wikis, blogs, and forums allow learners to enhance their critical thinking and collaboration skills when they are involved in written or oral group discussions. In addition to that, technological tools provide different learning experiences through audio-visual materials like podcasts and videos which allow teachers to convey information, illustrate phenomena, or deliver instructional simulations. As for interactive online materials, they allow learners to manipulate information through various tools like drag and drop exercises, highly immersive tools, interactive flash animations, virtual reality environments, simulations, and different sorts of tactile elements. Thus, the online

environment offers a plethora of services that offer new opportunities for both teachers and learners.

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