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A review of learning theories and models underpinning technology-enhanced learning artefacts

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Abstract

Purpose – Various technology-enhanced learning software and tools exist where technology becomes the main driver for these developments at the expense of pedagogy. The literature reveals the missing balance between technology and pedagogy in the continuously evolving technology-enhanced learning domain. Consequently, e-learners struggle to realise the pedagogical value of such e-learning artefacts. This paper aims to understand the different pedagogical theories, models and frameworks underpinning current technology-enhanced learning artefacts to pave the way for designing more effective e-learning artefacts.

Design/methodology/approach – To achieve this goal, a review is conducted to survey the most influential pedagogical theories, models and frameworks. To carry out this review, five major bibliographic databases have been searched, which has led to identifying a large number of articles. The authors selected 34 of them for further analysis based on their relevance to our research scope. The authors critically analysed the selected sources qualitatively to identify the most dominant learning theories, classify them and map them onto the key characteristics, criticism, approaches, models and e-learning artefacts.

Findings – The authors highlighted the significance of pedagogies underpinning e-learning artefacts. Furthermore, the authors presented the common and special aspects of each theory to support our claim, which is developing a hybrid pedagogical approach. Such a hybrid approach remains a necessity to effectively guide learners and allow them to achieve their learning outcomes using e-learning artefacts.

Originality/value – The authors found that different pedagogical approaches complement rather than compete with each other. This affirms our recommended approach to adopt a hybrid approach for learning to meet learners' requirements. The authors also found that a substantive consideration for context is inevitable to test our evolving understanding of pedagogy.

Keywords Learning theories, e-learning models, Technology-enhanced learning, Pedagogy, E-learning pedagogy, Online learning

Paper type Research paper

1. Introduction

A recent investigation into pedagogy reveals the little consensus upon one definition because of various reasons. *First*, the pedagogy as an interrelated concept should be considered within its larger educational practices, including technology-enhanced learning (TEL) (Cox, 2018). *Second*, our understanding of pedagogy has become more complex over time due to our growing comprehension of underpinning theories (e.g. cognition and metacognition; Waring and Evans, 2015). For this research, pedagogy is the dynamic relationship between learning, teaching and culture (Livingston *et al.*, 2017). This research aims at establishing a better understanding of pedagogy in TEL contexts that is inevitable to develop effective TEL

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artefacts. Such artefacts will have the right balance between technology and pedagogy, and consequently meet different learners' requirements based on their contexts (e.g. formal and informal learning). To establish a better pedagogical understanding, the following research question needs to be answered: what are the pedagogies/learning theories and models underpinning the existing e-learning artefacts? Answering this question requires further analysis to understand the dynamic conceptualisation of pedagogy in various TEL scenarios and how this might help throughout the design, development and use of TEL artefacts.

The rest of this paper is organised as follows: section 2 highlights the importance of learning theories and reasons behind rejecting the anti-theory argument in this research. Section 3 describes the methodology used to carry out this research, while section 4 analyses a set of selected learning theories that are heavily used in the TEL domain. Section 5 introduces a comparative view of learning theories and presents the framework to connect pedagogy and TEL practices. Finally, section 6 concludes the review and provides recommendations for developing effective TEL artefacts.

2. Pedagogy of learning

Learning environments have significantly evolved into complex, multipurpose, technology-intensive environments (Hammad *et al.*, 2017a, b). For instance, they integrate course/module-oriented capabilities with administrative, management and social tools in a complex architecture that can be integrated with external tools. This cross-domain, rapid and intensive development requires dismantling the underpinning pedagogical theories/models to guide learners and understand their behaviour. During the investigation of this research problem, the literature reveals two arguments. The first is the anti-theory argument, which does not believe in theories because the learning phenomenon cannot be explained by simple theories (Kolb and Kolb, 2009). The second argument, adopted in this research, considers learning theories as an essential component of teaching and learning because they are inevitable in any good pedagogical design (Schunk, 2012). The importance of learning theories, in this context, stems from the fact that TEL artefacts are more than vehicles to convey information to users. They are providing mechanisms to construct knowledge and build new cognitive structures inside a learner's mind. Hence, it is very essential to look into these artefacts from this perspective.

As learning is the process by which behavioural change, knowledge, skills and attitudes are acquired, a learning theory, or a combination of them, is needed to explain it (Singh and Thurman, 2019). This is valid on theoretical and practical levels, e.g. information processing theory combines the behaviourist and cognitive theories (Pratiwi *et al.*, 2019). In this research, a theory refers to a comprehensive, coherent and internally consistent system of ideas about a set of phenomena (Knowles *et al.*, 2015). This research investigates learning theories that influence learning and provide explanations of the ways in which that influence happen. Delineating e-learning theories is out of scope, as they overlap with other theories, e.g. human–computer interaction (Deshwal *et al.*, 2017). In the next section, the methodology of carrying out this research is explained.

3. Methodology

Conducting this review is quite challenging due to the interdisciplinary nature of the research problem. Such interdisciplinarity is obvious in the previously identified research question, i.e. what are the pedagogies/learning theories and models underpinning the existing e-learning artefacts? To answer this question, the following method has been adopted to review the related literature. It is composed of the three following phases: (1) planning, (2) conducting and (3) reporting the review. In the planning phase, researchers used the following five major

scientific databases: Springer, EBSCO, Eric, ACM and SCOPUS, to extract relevant literature resources. The key criterion for paper selection is as follows: selected papers should describe learning theories and models that are: (1) widely used in the TEL domain and (2) their implications on learning and teaching practices are important to this research context. The outcome of this phase is 38 research papers that discuss learning theories and models underpinning TEL artefacts from a technical and pedagogical point of view. The selected papers have been analysed and reviewed in the second phase to extract lessons learnt from these studies. In addition, this analysis has led to identifying learning theories/models' strengths, i.e. where they perform well, and weaknesses, i.e. where practices need to be improved. In this way, we understand the potential of using a certain theory in a certain TEL scenario and justify the best way of combining two or more learning theories in one TEL scenario. The final phase is to report the findings in facts, figures or other formats. The rest of this paper is organised as follows: section 2 justifies the importance of learning theories, section 3 analyses learning theories from individual and collective perspectives, section 4 introduces a comparative view for learning theories and section 5 concludes the review and provides a list of recommendations to be considered in developing effective TEL artefacts. In the next section, an analytical review of learning theories that are widely utilised in TEL contexts is presented.

4. Learning theories

First, this section addresses the commonly used learning theories in the e-learning context and reflects on various interrelated concerns/classification. Secondly, it concludes with a comparative summary to present common and special features of each approach to pave the ground for developing an innovative TEL framework.

4.1 Learning theories: individual approach

4.1.1 Behaviourism. Behaviourism was initially developed in the 1920s with its golden age in the 1950s. Behaviourism defines learning as a sequence of stimulus and response actions in observable cause-and-effect relationships (Mechlova and Malcik, 2012). Behaviourism considers the learner's mind as a black box while always focusing on the changes in the learner's behaviour (Kruse, 2009). It is associated with a number of theorists, e.g. Pavlov and Watson; however, Skinner's view is currently the most dominant (Bates, 2019). Behaviourism is divided into *classical conditioning*, which refers to natural reflexes in response to various stimuli, and *operant conditioning*, which refers to the reinforcement of these responses through extrinsic rewards/punishments so that such responses become more/less probable in the future (Usman and Ogbu, 2019). On the one hand, behaviourism is attractive because it easily explains some learner actions (Aubrey and Riley, 2018). On the other hand, it does not explain internal learning processes or learners' reasoning and thinking, especially higher-level critical thinking skills and problem-solving (Agarkar and Brock, 2017). Despite this criticism, behaviourism forms the basis for various intelligent tutoring systems and instructional system design models.

4.1.2 Direct instruction (DI). Direct instruction (DI) refers to the academic focus, precise sequencing of content, high learner engagement, careful teacher monitoring and corrective feedback to learners (Datchuk, 2017). This contradicts with exploratory models, e.g. inquiry-based learning. DI is composed of the following activities: (1) *presentation*, which introduces knowledge and concepts, and reflect upon them; (2) *practice*, which allows learners to practice learnt knowledge under guided and independent practice schemes; and (3) *assessment and evaluation*, which include formative and summative assessment (Stockard *et al.*, 2018). DI puts further emphasis on practice, close observation and feedback; however, it keeps learners away from the centre of the learning process.

4.1.3 Cognitivism. Cognitivism behaviourism's failure to explain different learning processes led to the so-called cognitivist revolution, which replaced behaviourism in the 1960s as the dominant paradigm (Watrin and Darwich, 2012). Cognitivists believe that mental processes are essential for explaining behaviour. Hence, cognitive theories focus on how learners make meaning out of new information and experience. Cognitive learning theories include constructivist, developmental and social learning theories. Each of these emphasises how meaning-making processes are affected by various factors (Kruse, 2009). Kruse believes in using behavioural alongside cognitive theories for effective instruction, while other educationalists see cognitive associated with different learning theories, such as information processing theory in addition to constructivism (Usman and Ogbu, 2019). The information processing theory considers the mind as a computer, which means that both humans and computers accept inputs, process them using previous knowledge and long-term memory and produce outputs (Pratiwi *et al.*, 2019). Cognitivism is effective because it has led to various inventions, including: (1) adaptive systems that analyse learner responses and direct his/her to appropriate actions and (2) artificial intelligence (AI)-based techniques that represent the mental processes used in human learning (Bates, 2019). However, from an epistemological perspective, cognitivism belongs to an objectivism view, which means that knowledge is absolute, matches reality and exists outside the human mind independently of what an individual may or may not believe (Harasim, 2012), which is not true for all kind of knowledge. Particularly, for this reason, we cannot see cognitivism as the opposite of behaviourism.

4.1.4 Social learning theory. The social learning theory links learning with its social contexts/perspectives. For instance, Wenger recognises learning as a social process (Farnsworth *et al.*, 2016). Similarly, Bates explains that knowledge is either acquired through a *social process* or *institutions that are socially constructed* (e.g. schools). Consequently, knowledge is conceptualised as *content* plus the socially constructed *value* (Bates, 2019). In the social learning theory, knowledge is constructed via social interaction, and learners learn from observing and interacting within social and cultural contexts, e.g. social learning environments. Such environments are built by learners using a collection of social tools, e.g. social networking, tagging, blogging, etc. But, these socially rich environments may distract learners from achieving their goals as they lack effective support. The social learning theory is related to cognitivism because it admits the existence of individual intelligence and reasoning (Farnsworth *et al.*, 2016).

4.1.5 Constructivism. Constructivism, unlike behaviourism and cognitivism, takes a holistic approach, where each learner, individually and socially, constructs his/her own knowledge/meaning while he/she learns Hence, learners make sense of their external environments by a meaning-making process that depends on previous internal experiences (Mattar, 2018). Constructivism assimilates most of the cognitive-based theories, e.g. information processing and social learning; constructivism is not as deterministic as behaviourism and some cognitivism elements in terms of predictable learner's behaviour. Constructivists focus on the uniqueness of learners as humans are very dynamic in nature; their views and values change over time, and this change impacts future knowledge. Moreover, the learner is at the centre of a continuously changing rich world of facts, experiences and knowledge. Hence, every learner is unique, his/her behaviour is not predictable/deterministic and he/she uses previous knowledge to make meaning of his/her environment. When learners see new information, they either *assimilate:* fit new information within their existing mental framework or *accommodate*: add to/modify their existing mental framework. Constructivism has been criticised because mistaken mental frameworks might be used to construct new knowledge, and it is not easy to discover/modify mistaken mental frameworks.

4.1.6 Connectivism. Connectivism emerged based on evolving educational technology advancements. These advancements reveal the following drawbacks of behaviourism,

cognitivism and constructivism: their intrapersonal view of learning, their failure to address learning located within technology/organisations and their lack of contribution to the value judgments that need to be made in knowledge-rich environments. Therefore, Siemens introduces the main principles of connectivism as a new learning theory as follows (Siemens, 2018): (1) learning and knowledge rest in the diversity of opinions; (2) learning is a process of connecting specialised information sources; (3) learning may reside in non-human appliances; (4) the capacity to know more is more critical than what is currently known; (5) nurturing and maintaining connections is needed to facilitate sustained learning; (6) the ability to see connections between fields, ideas and concepts is a core skill; (7) accurate and up-to-date knowledge is a must; and (8) choosing what to learn and the meaning of incoming information is a learning process.

Connectivism is the first attempt to radically re-examine the implications of technological advancements on learning (Bates, 2019). It creates an opportunity to understand new learning models that emerged out of technological developments because it extends learning outside the learner. Yet, Siemens's description of connectivism as a successor to behaviourism, cognitivism and constructivism can be easily challenged because it neither adds to the principles of existing theories nor explains how learning can reside in non-human appliances. Additionally, learners struggle in unstructured learning environments, lack control and get overwhelmed by peer-generated contents and need explicit support (Bates, 2019).

4.1.7 Learning by doing (LBD). Learning by doing (LBD) is a broad paradigm established to support the experiential learning theory (ELT) and situated learning and similar themes (Feng *et al.*, 2013) LBD requires learners to perform tasks that have to be learnt, which means learning takes place while performing tasks. Evidence shows that LBD can achieve better results than other learning methods (Leyer *et al.*, 2014), significantly minimises the cost of learning, promising for novice learners, useful for teaching motor skills, laboratory studies, medical internships and other disciplines, a useful adjunct to traditional learning. However, it is context-dependent, which limits its reusability in other contexts (Feng *et al.*, 2013), and therefore, it is not highly useful for conceptual learning. LBD is tightly coupled with ELT, which emphasises on the process whereby knowledge is created through the transformation of experience. Hence, knowledge results from the combination of grasping and transforming experience. Therefore, learning is divided into *cognitive,* which corresponds to academic knowledge, and *experiential,* which refers to applied knowledge. Nevertheless, successful LBD requires the quality of personal involvement, the pervasive effects on the learner and ability to extract meanings that are built into the whole experience (Johnston and Sator, 2017).

Other approaches, e.g. problem- and project-based learning, are classified as experiential learning techniques (Furman and Sibthorp, 2013). Problem-based learning uses learners' interest in a given problem to create an experiment to develop a course of actions that help in resolving the problem. By contrast, project-based learning creates content-rich projects based on learners' interests to involve learners (Lima *et al.*, 2017). Project-based learning enables learners to grasp subject-specific skills in addition to a wide range of skills, e.g. time management, planning and group dynamics. However, LBD/ELT promotes an individualised perspective of learning at the cost of social, cultural and non-cognitive learning aspects and does not reflect on unconscious learning processes which might lead to/or prevent learning activities (Lima *et al.*, 2017).

4.1.8 Self-regulated learning. Self-regulated learning (SRL), despite e-learning, has the potential to enhance learning processes, diverse difficulties, e.g. cognitive overloading and disorientation face learners when they learn from the Web. Therefore, SRL and self-directed learning (SDL) have gained more attention as they help in regulating learning to avoid such difficulties. SDL tends to refer to more autonomous learning. Both SRL and SDL are used interchangeably in the literature (Saks and Leijen, 2014); differences and similarities are highlighted in Figure 1. A learner is self-regulated to the extent that he/she is a

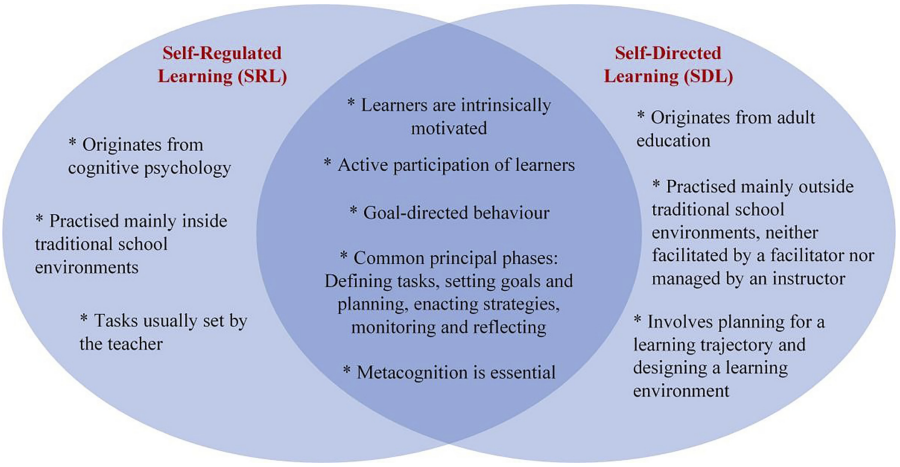

Figure 1.
Self-Regulated Learning vs Self-Directed Learning

metacognitively, motivationally and behaviourally active participant in his/her learning process (Wong *et al.*, 2019). This involves taking the initiative to diagnose learning needs, formulate learning goals, identify resources, select and implement learning strategies and evaluate learning outcomes (Saks and Leijen, 2014). Hence, successful self-regulated learners work on *cognitive skills*, e.g. analysis and reasoning, and *meta-cognitive skills,* e.g. reflection and self-assessment.

SRL's key phases are: (1) *cognitive planning and activation*, which includes: goal-setting, activation of prior content knowledge and activation of metacognitive knowledge; (2) *cognitive monitoring*, which involves awareness and monitoring of cognition, especially metacognitive judgement of the learner her/himself; (3) *cognitive control and regulation*, which includes cognitive and metacognitive activities that learners engage in to adapt and change their cognition; and (4) *cognitive reaction and reflection*, which involves the learner's judgments and evaluation of their performance (Stebner *et al.*, 2019). SRL requires skilled learners because they should use several cognitive strategies, e.g. rehearsal, elaboration, organisation and critical thinking to plan, monitor and regulate their learning. Moreover, contextualisation is necessary to stimulate prior knowledge activation on the content level of metacognitive knowledge level (Stebner *et al.*, 2019). Nonetheless, SRL is considered as cognitive constructivism because learners use self-regulatory skills to control and direct their cognition, which seems a promising future research direction.

4.2 Reflections on learning theories analysis

Lessons learnt reveal the importance of analysing various learning theories, as they complement rather than compete with each other. We argue that boundaries between learning theories are not clear to the extent that one learning model can be mapped to one learning theory. This is also valid on abstraction levels where these theories are originally derived from (e.g. constructivism and cognitivism belong to different epistemological schools). This entangled conceptualisation of learning is obvious due to the nature of learning theories and the way they have been discovered. This is also reflected in the various classifications of learning theories that exist in the literature. Many of these classifications look into learning theories from one perspective such as epistemology or psychology. Nonetheless, researchers adopt Mayes and de Freitas classification (2012), with slight changes, due to its comprehensive and clear conceptualisation of learning and how it occurs.

According to Mayes and de Freitas (2012), learning theories are classified into three perspectives: *associationist*, i.e. activity-oriented; *cognitive*, i.e. understanding-oriented; and *situative*, i.e. socially oriented. In the first perspective, knowledge is an organised accumulation of associations and skill components, and learning is the process of connecting the elementary mental or behavioural units through sequences of activity. Behaviourism, DI and instructional design fall into this perspective. In the second perspective, learning is a way to model the processes of interpreting and constructing meaning. Knowledge acquisition is the outcome of an interaction between previous learner structures for understanding and new experiences. In the third perspective, learning is seen as situated within social and cultural contexts. Consequently, these contexts affect learning outcomes, knowledge, learner's ability to learn through participation and learner identity that is shaped by the learner's relationship with the community (Bates, 2019). Connectivism and community of practice learning theories are examples of this perspective. In this perspective, the quality of learning is the outcome of the learner's participation in their contexts, i.e. community, artefacts, cultural and social aspects. Immersive-based, collaborative-based learning, authentic simulations and game-enhanced learning are examples of e-learning models underpinned by situated learning theories as long as they considerably embrace contexts (Dawley and Dede, 2014).

Unlike Mayes and de Freitas (2012), we argue that constructivism assimilates cognitivism because constructivism is not deterministic like some aspects of cognitivism. Constructivism considers individuals are unique, and one's experience is continuously evolving, which leads to different mechanisms for information processing and understanding the underlying meanings. Figure 2 reflects our view on the tangled boundaries between the two main learning theories. It shows how behaviourism tends towards individualistic, instructor-centred, determinism, objectivism and DI. By contrast, Constructivism tends towards the opposite qualities, e.g. learner-centred. Constructivism also covers a wide spectrum of theories ranging from cognitive constructivism, derived from Piagetian constructivism, to social constructivism, derived from Vygotskian constructivism, which includes collaborative constructivism. If the *two-main-opposite-extremes* classification needs to be adopted, then constructivism and behaviourism are the two opposite extremes. In addition, it alludes to the dynamic nature of pedagogy because behaviourism can be learner-centred, despite the mistaken view that it is instructor-centred only (de Freitas and Jameson, 2012).

Similarly, constructivism can lean towards *behaviourism* if the focus shifts towards feedback; *cognitivism* because it assimilates most of the cognitive-based learning theories or *situative* if the focus shifts towards authentic learning activities. Other e-learning models,

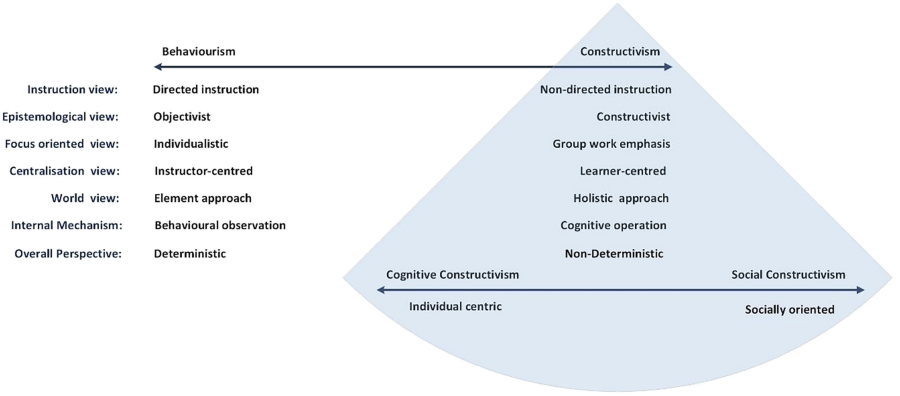

Figure 2.
Learning theories from different views

e.g. simulation-based, can be situative as long as the acquired meaning and knowledge are personally and socially constructed through interpersonal participation, e.g. creating, sharing and reflecting, interpersonal relationships and social participation within communities. Despite cognitivism potential to explain how humans make sense of new experiences, further research is needed to explore how to advance human capabilities, e.g. critical thinking and adaptivity, can be explained.

5. Learning perspectives: comparative view

Table 1 shows a comparative summary of the learning perspectives, theories and pedagogical models and frameworks used in e-learning contexts. It provides answers for the previously identified research question by explaining the common learning theories along with their strengths and weaknesses. It extends the information presented earlier by linking them up with epistemological, world and applications views. Most of the literature cited above is used to combine the content of this table especially (Agarkar and Brock, 2017), (Mayes and de Freitas, 2012), (Hammad *et al.*, 2017a, b) and (Stevens-Fulbrook, 2020). Figure 2, provides further information about learning theories. For instance, the world view refers to (i) an elemental model that represents the universe as a machine composed of discrete pieces operating in a spatiotemporal field or (ii) a holistic model that represents the world as a unitary, interactive, developing organism (Knowles *et al.*, 2015). Furthermore, considering the epistemological point of view can be useful in such analysis, as epistemology deals with the study of the origin, nature, limits and methods of knowledge (Schunk, 2012). The table also shows key figures, including propounders and interpreters, because some key figures from the same perspective represent different views, which consequently has led to the evolvement of different e-learning models.

The above comparative view answers the research question by explaining learning theories that underpin a wide range of TEL artefacts. It is obvious that each learning theory has its ideal context to deliver value to practitioners. To build effective TEL artefacts, the following recommendations have been suggested, as summarised in Figure 3. *First*, context matters. The context embraces numerous information from learning settings (i.e. formal or informal), topics taught (e.g. medicine and engineering), learner preferences, skills to be learnt and activities. *Second*, the importance of building a coherent pedagogy that helps learners to achieve their learning objectives. This pedagogy should be based on a combination of learning theories and educational practices. This is crucial for the successful application of innovative technologies in education. For instance, applying blockchain technology in education significantly increased over the past few years. Micro-credential learning is one of the blockchain applications in education where students are allowed to combine their degrees from different programmes/universities (Chen *et al.*, 2018). Such combination requires coherent application and tacking of learning processes provided by different partners, which needs to be built based on well-articulated pedagogical models.

Third, current learning environments are increasingly becoming more complicated. This includes the use of up-to-date technical platforms/tools such as educational chatbots, where learners are expected to chat, via text or voice, with machines to get the required support for their learning and teaching. Unlike traditional educational systems, e.g. learning management systems (LMS), where educational data are structured and stored in documents, data here are structured differently and various AI technologies are employed to allow machines to intervene and act on behalf of lecturers. Integrating chatbots with existing learning environments, e.g. LMS, necessitates the use of proper guidelines such as Talk2Learn Framework to consider various related factors, including pedagogy, processes, policies, etc. (Bahja *et al.*, 2019). Consequently, learners will have access to the guidance they need to achieve their goals. Hence, chatbots need to respond differently to those who are

Table 1.
Comparative summary for theories/models used in TEL

#	Perspective	Metaphor	World view	Influential figures	Epistemological orientation	Key characteristics	Key criticism	Main approaches	Pedagogical models and frameworks	Potential e-learning models
1	Associationist	Learning as Activity	Elemental model	John B. Watson Ivan Pavlov B. F. Skinner, Edward Thorndike Edward Tolman	Objectivism: Reality is independent from human and external Knowledge is absolute and matches reality	Learner's mind is a black box, while the focus always goes to the changes in a learner's behaviour	Cannot explain complex learning processes It refuses references to feelings and attitudes	Behaviourism Instructional system design E-training Intelligent Tutoring Computer-aided instruction	Merrill's instructional design Direct instruction model	Interactive content delivery system based on assessment and feedback
2	Constructive/ cognitive	Learning as achieving understanding	Elemental model	*a) Cognitive learning theories:* David Merrill, Charles Reigeluth, Leslie Briggs, Albert Bandura, David Ausubel	Objectivism: Reality is independent from human and external to him/her Knowledge is absolute and matches reality	Mental processes are essential for explaining behaviour More focus on how learners make their own meanings based on the new information and experience	Objectivism's view is that truth exists outside the human mind or independently of what an individual may or may not believe, which is true some cases	Constructivism Problem-based learning	Kolb's Learning cycle Learning styles	Adaptive and intelligent learning system
			Holistic model	*b) Constructive learning theories:* Lev Vygotsky, Jean Piaget, Mitchell Resnick, John Dewey, Jerome Bruner	Constructivism: knowledge is created to fit with reality, or knowledge depends on the knower's frame of reference	Each learner individually and socially constructs meaning while he/she learns Learners make sense of their external environments by a meaning-making process, which depends on previous experience	Does not consider emotional aspects, affective human characteristics and situations or experiences causing them	Experiential learning Learning by doing SRL/SDL	Laurillard's conversational framework Community of inquiry framework	Asynchronous and synchronous dialogue

(*continued*)

Table 1.

#	Perspective	Metaphor	World view	Influential figures	Epistemological orientation	Key characteristics	Key criticism	Main approaches	Pedagogical models and frameworks	Potential e-learning models
3	Situative	Learning as social practice	Holistic model	John Seely Brown, Allan Collins, Paul Duguid, Jean Lave, Ettienne Wenger, George Siemens	Constructivism: knowledge is created to fit with reality	Consider social interaction Learning is social participation within a wider sociocultural context of rules and community Learner knowledge and identity are affected by the community of practice	Context is important in situated learning Also, when education is the main target as opposed to fun or socialisation, learner motivation and engagement might decrease	Cognitive apprentices hip Case-based learning Scenario-based learning Collaborative learning Social constructionism	Wenger's community of practice Connectivism Activity theory	Different tools that create opportunities for social interaction (e.g. social network)

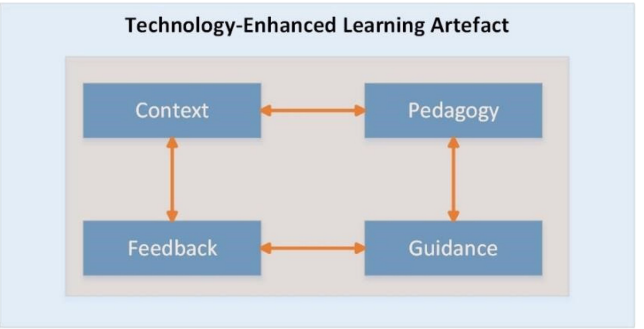

Figure 3.
TEL artefact considerations

learning in self-regulated approaches than learners following instructor-led approaches. In the former, learners are more independent and have more control over their learning processes, so they are looking for help in setting up their learning goals, comments on their higher-order thinking skills such as reflections and so on. In the latter, learners are after finding more direct information regarding how to proceed in certain learning processes or how to submit a project, to mention but a few. In addition, it has been found that using well-structured pedagogical understandings is aligned with good software engineering principles such as user-centric development for TEL artefacts (Bahja *et al.*, 2020).

Fourth, the need for getting effective feedback from users. This feedback includes results of various pedagogical applications, learners' achievements, etc. *Fifth*, the need for a hybrid framework to syndicate the previous recommendations in one artefact. Such artefact will allow authentic testing for our understanding of pedagogy and whether we have achieved a reasonable balance between technology and pedagogy. Despite the central importance of this topic, it has not been addressed to the sufficient level and hence requires further investigations. The above framework summarises the key considerations to be addressed by TEL artefacts designers and developers. Underneath each of the highlighted considerations, i.e. context, pedagogy, guidance and feedback, a complete set of questions need to be answered by TEL artefacts designers. For instance, before designing a specific TEL artefact, designers need to ask themselves what kind of contexts can accommodate the proposed artefact/software and why? Answering these questions will allow to inquire the pedagogical models that need to be in place for students; this mainly answers the questions of how students are going to use the proposed artefact. On top of that, what guidance is needed for successful use of this artefact. This is mainly about the precise specification of the process of using the artefact in different scenarios. And finally, what feedback is expected to be generated out of this use. It is also important to pay attention to the bidirectional arrows between factors, e.g. context influences feedback, and also feedback generated from stakeholders enforces stakeholders to adapt the context of learning or some of its aspects. To summarise the above discussion, early conversations need to be established with the users of any proposed TEL artefact based on its pedagogical value, e.g. collaborative learning. Then, discussion should clarify the best technical options to achieve these values in an inclusive way, e.g. sharing documents, creating collaborative spaces, to mention but few.

6. Conclusions and future work

This review answered the early-identified research question by discussing the most dominant learning theories that underpin various TEL artefacts. Consequently, it presented five key recommendations to build effective TEL artefacts. In addition, this conclusion

confirms the following points. *First,* TEL pedagogy should be thoroughly considered because technology evolves, and consequently, more complicated technological environments appear, which require more explicit pedagogical consideration. For instance, the innovative use of natural language processing (NLP) might be extremely useful to analyse a learner's responses and consequently align them with certain pedagogical approaches such as social constructivism. Hence, sufficient directions on how to use NLP for education are needed (e.g. Bahja, 2020). *Second*, learning theories explain how different learners learn, yet they do not tell them how to learn. Therefore, pedagogy might help to design a process that guides learners to learn effectively. Tracking a learner's behaviour is useful in this context. For instance, adopting learning analytics algorithms and techniques paves the ground to understand a learner's actions over time, which is known as the temporality of learning. *Third,* because pedagogy is dynamic, we need to test our understandings of pedagogy in the context of TEL through incorporating pedagogical components in newly developed artefacts. *Fourth*, as learners combine learning theories to learn different skills, the developed artefacts should adopt hybrid pedagogical models. *Fifth*, context matters, and the pedagogy definition adopted in this research illustrates the wide range of factors that impact learning and consequently contribute to building effective TEL artefacts.

Finally, the discussion highlighted the need to specify different pedagogical processes that could guide learners to achieve their learning goals, which will be the future direction of this research. This is part of an ongoing research to specify various learning processes and potential ways to decouple technical issues from learning activities. The presented framework explains, briefly, the relations between key considerations needed for effective TEL artefacts design and development, but this needs further clarifications in terms of instantiation processes for this framework. In addition, specifying neutral pedagogical e-learning processes will take us to the next stage of future directions, which is developing effective TEL artefacts to test our understanding for e-learning pedagogies. Both future research directions will be investigated in an interdisciplinary approach to create the required balance between pedagogy and technology, so TEL artefacts become driven by pedagogy and facilitated by technology, and not the other way around.

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