From Behaviourism to Connectivism and Beyond: Evolving Theories for Technology-Enhanced Education

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ABSTRACT

Digital pedagogy has transformed the theoretical framework of technologies-enhanced learning, such as e-learning, blended learning, and distance education, that has grown rapidly. The development of learning theories since the time of behaviourism and cognitivism through constructivism, social constructivism and connectivism, as well as the analysis of modern theoretical frameworks like Activity Theory, Learning Analytics, TPACK, SAMR and rhizomatic/networked learning, are presented in this study. This paper presents empirical findings and a literature review done within the last ten years; therefore, drawing on these findings, this paper argues that technology-enhanced learning can be effectively done based on a multi-theoretical and integrated approach that can co-align pedagogical goals with digital opportunities and socio-cultural backgrounds. The examples are illustrative of how hybrid theoretical frameworks can be used to design courses, create assessment plans, and community-building in online and blended classes. Two conceptual maps: a historical roadmap and a synthesized theoretical map are provided to help educators and researchers in knowing how the traditional theories and the contemporary frameworks correlate with each other. The paper ends with the further research directions, such as the synthesis of the theory, cross-disciplinary discovery, and implications of the emerging technological tools, which are artificial intelligence and immersive learning environments, to the pedagogical process.

Keywords: Blended Learning, E-Learning, Learning Theories, Learning Technologies

INTRODUCTION

The blistering development of digital technologies over the last 20 years had a significant impact on higher education practice, and student expectations. Learning Management Systems (LMs), mobile devices, MOOCs, social media platforms, adaptive learning systems, and learning analytics have become the tools that offer various ways of imparting knowledge and a way in which learners can interact (Bates, 2019; Dalsgaard, 2023). Nevertheless, technology is not pedagogically neutral, and its application in teaching and learning situations displays either implicit or explicit beliefs regarding the process of learning. Subsequently, the educational research and contemporary instructional design continue to emphasize more on the theoretical alignment, making it a deliberate attempt to match digital tools being purposefully incorporated with pedagogical objectives, specific learner's requirements, and socio-cultural backgrounds.

Although classical learning theories, such as behaviourism, cognitivism, or constructivism, are still relevant to education practice, the contemporary environment has extended further to acquire frameworks that can focus on the complexity of technology-mediated learning. They are pedagogical-technology integration models (e.g., TPACK, SAMR), data-driven paradigms (Learning Analytics), socio-technical paradigms (Activity Theory), and network-oriented paradigms (Connectivism, Rhizomatic Learning, and Community of Inquiry).

The current systematic reviews and the empirical research point to the increasing trend of a shift toward theoretical synthesis, where the researchers and practitioners integrate various perspectives to implement flexible, evidence-based digital learning environments (Kholid *et al.,* 2023; Blundell *et al.,* 2022).

This paper integrates foundational learning theories with contemporary technology-enhanced learning frameworks, drawing on current literature to highlight key empirical insights, and their implications for instructional design.

1. Behaviourism and the Continuing Role of Reinforcement in Digital Learning:

The approach to teaching digital characteristics by behaviourism, focusing on behaviour and re-enforcement, prepared the foundation of early technologies in instruction, and is still applicable to particular areas of digital pedagogy. Repeat, instant feedback, and incremental mastery are behaviourist concepts of learning, which can be found in programmed instruction, drill-and-practice applications, and automated formative assessment (Skinner, 1968). Modern adaptive learning systems (whereby performance information is used to offer the next task based on the performance of the learner) can be interpreted behaviouristically in their functionality--despite the use of data-driven personalisation. Recent impacts on adaptive systems emphasize the efficiency of instantaneous feedback and interval practice in retention by demonstrating that the behaviourist mechanisms can still play a role in scaffolding of fundamental skills in digital contexts. (BaniHashem *et al.,* 2022).

Nevertheless, there is ample evidence of behaviorism's shortcomings. Internal cognitive structures, social interaction, and networked knowledge creation areas where more recent frameworks offer more explanatory power are not taken into consideration. Therefore, it is advisable to utilize behaviorist approaches sparingly within more comprehensive multi-theoretical frameworks that also incorporate cognitive, social, and networked components. (Skinner, 1953; modern syntheses: Ertmer & Newby, 2013)

2. Cognitivism and Multimedia/Instructional Design in E-learning:

Cognitivism became focused on the mental activities, memory, schema and processing information (Piaget; Bruner; Gagné). The principles of multicodal content and multimedia in digital learning directly derive out of the cognitive theory segmenting content, signalling critical information, and alignment of verbal and visual channels in order to load the cognitive process with less extraneous information (Mayer, 2009). The recent instructional design literature still confirms that cognitivist-informed methods of enhancing understanding and mitigating overload in online courses (Gagné sequencing adapted to LMS learning programs) continue to be the key factors behind e-learning, and that well-designed multimedia plays a central role in modern e-learning. This is supported by empirical research findings, which reveal that better learning gains are achieved when multimedia materials are presented in accordance with the principles of cognitive design. (Du-Preez and Jacobs, 2025).

Simultaneously, scientists caution that the deep learning cannot be achieved solely by using cognitive strategies in the absence of social interaction and real tasks. Cognitivist design, therefore, needs to be combined with social and constructivism strategies in order to promote application and transfer.

3. Constructivism: Active Learning, Authentic Tasks, and Online Collaboration

Constructivist ideologies reconsider the learner as an agent of knowledge, which a priori fits better the project based, inquiry based digital experiences. Co-construction of knowledge across distance is done as a result of online collaborative tools, including discussion forums, wikis, shared documents, and project-management platforms, which makes it possible to solve problems in authentic ways in virtual environments (Jonassen, 1999). Constructivist digital activities improve problem-solving and critical thinking with scaffolds and objectives, which are observed in the literature. However, meta-analytic and review studies (e.g., Kirschner, Sweller, and Clark, 2006) warn that less instructed constructivist strategies do not generally perform as well as guided instruction; except in instructional contexts based online, facilitation and scaffolding are crucial in constructivist pedagogical practices.

4. Social Constructivism, Community of Inquiry, and Presence in Online Environments

The social constructivism underlines the social construction of learning as the use of language, interaction, and cultural tools (Vygotsky, 1978). The Community of Inquiry (CoI) model translates these concepts into an online

setting through foregrounding cognitive, social, and teaching presence as mutually supportive units that create significant learning experiences (Garrison, Anderson, and Archer, 2000). Recent empirical research supports the primacy of CoI constructs: For instance, Zhang et al. (2023) have been able to find that teaching and social presence are strongly related to learner engagement and perceived learning in online courses in higher education. Studies on reviews and instrument development are still underway to improve the measuring and flexibility of CoI in the different cultures, which indicates that CoI still has a role to play in designing and evaluating courses in blended and fully online course delivery. (Chuane, 2025)

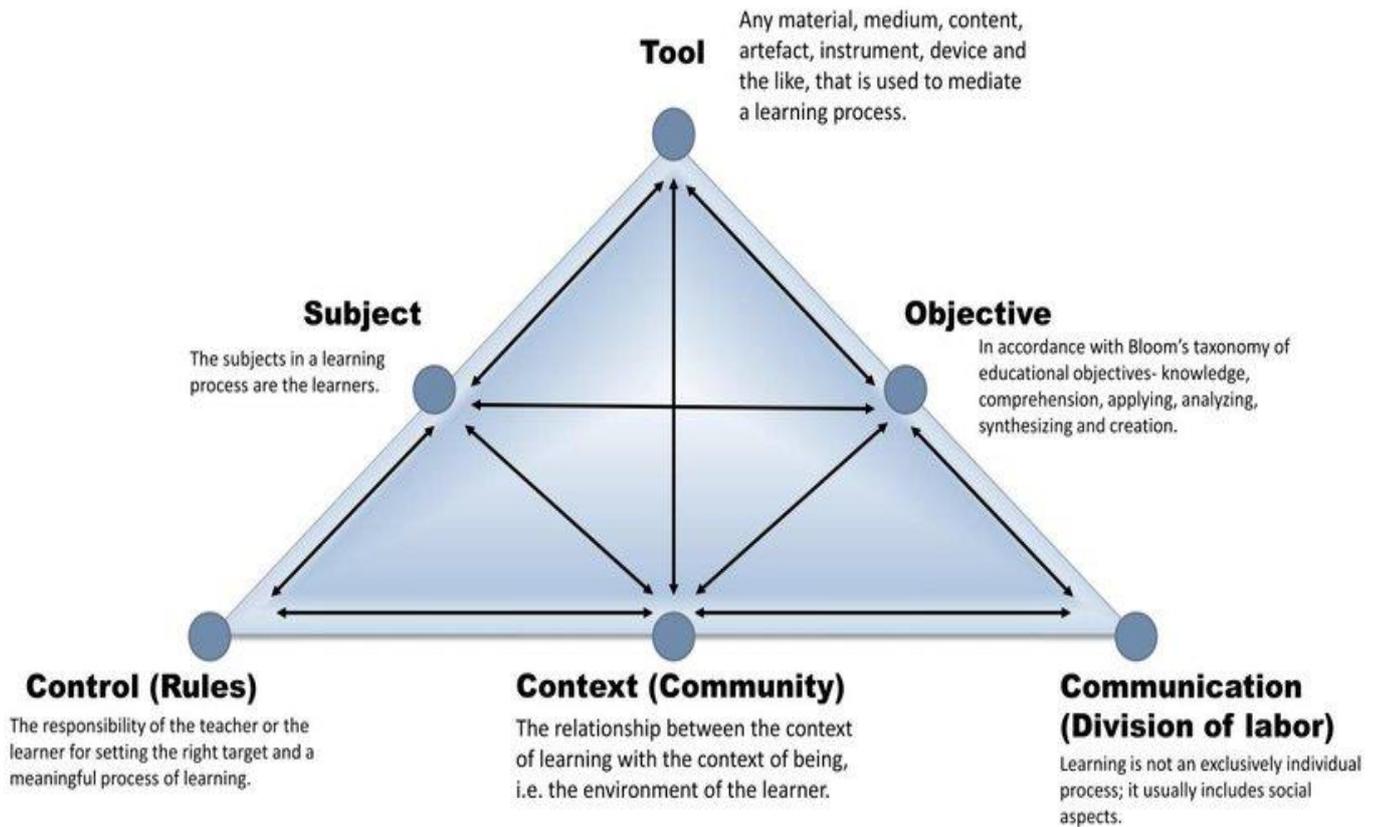## 5. Connectivism, Rhizomatic Learning, and Networked Knowledge

Networked knowledge in the digital world is dealt with in connectivism (Siemens, 2005) and other concepts like rhizomatic learning (Cormier, 2008). These views emphasize the idea that knowledge is disseminated through networks and that the learning process is more about capacity to navigate, curate and contribute to networks of information. How learners create nodes in larger knowledge networks is evident in the emergence of MOOCs, PLN, and social media-mediated learning. Recent criticism of connectivism is based on its theoretical limitations and lack of empirical support, however, empirical studies of networked learning and rhizomatic pedagogies (e.g., studies of cMOOCs and social media learning) indicate that there are practical advantages of being a learner of less-centered educational approaches, namely, autonomy, creativity, and open knowledge practices (Bozkurt et al., 2016).

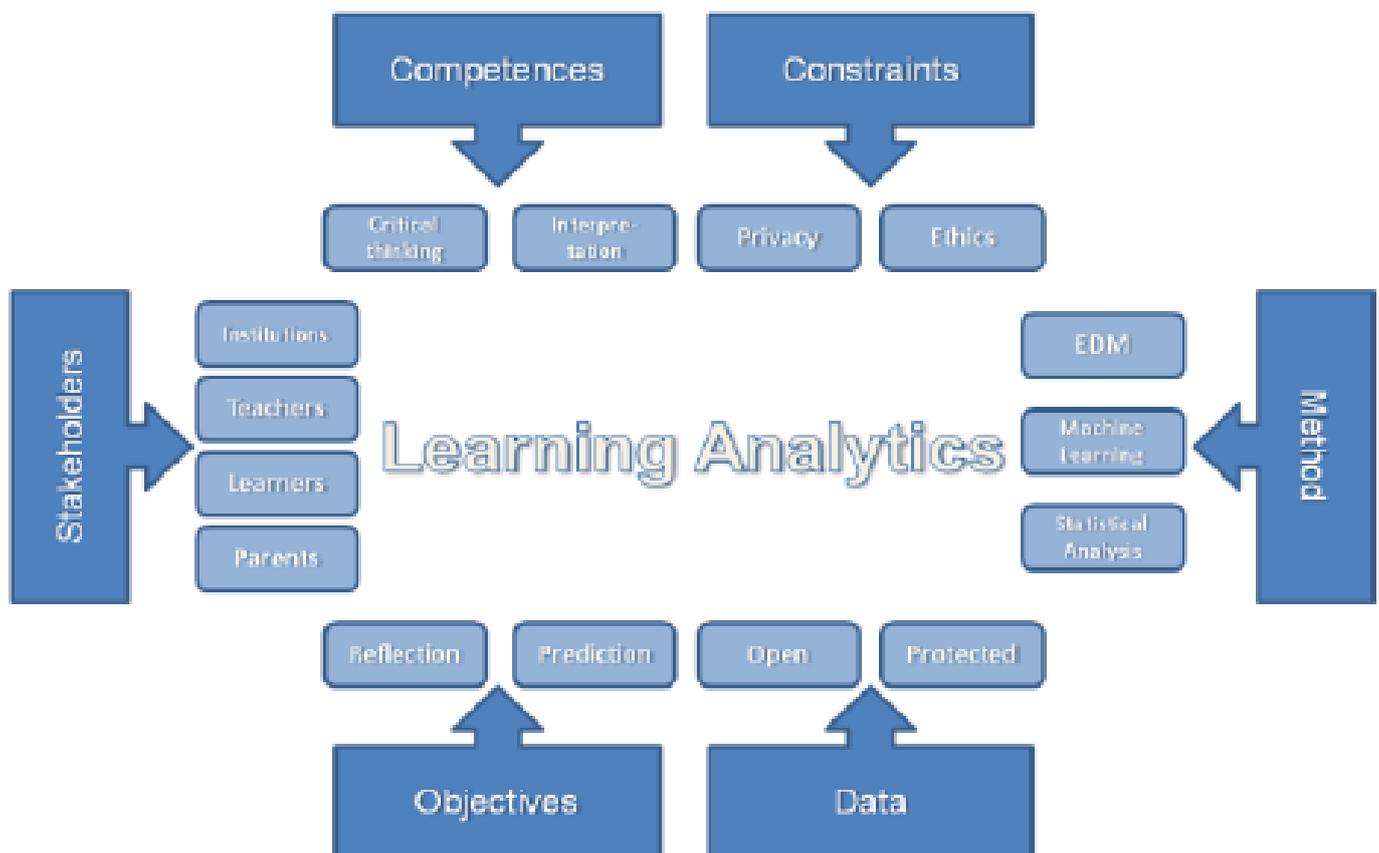## 6. Contemporary Frameworks: TPACK, SAMR, Learning Analytics, and Activity Theory

In addition to classical theories, the past 15 years have given rise to those frameworks that are technology and practice oriented. TPACK (Technological Pedagogical Content Knowledge) defines what content teachers must understand in order to make effective use of technology, and recent systematic reviews show that the field of TPACK research is active and developing, especially in subject specific contexts and with the focus on context as a domain of knowledge (e.g., Kholid *et al.,* 2023; Joshi, 2023). SAMR (Substitution, Augmentation, Modification, Redefinement) provides a practical taxonomy to assess the extent of technology integration; current scoping reviews demonstrate that SAMR has been widely applied to practice-based research and that it has also been interpreted and used in various ways (Blundell *et al*., 2022).

Learning analytics (LA) has become a both viable and academic discipline: LA is a combination of data science, pedagogy, and ethics to offer practical insights on teaching and learning. Systematic reviews (e.g., Khalil *et al.,* 2022; Banihashem *et al.,* 2022) chart the various theoretical frameworks within the domain of LA and highlight the potential of LA to improve feedback, personalization, and early-warning systems, as well as warning about the issues of validity, equity, and ethical governance. The socio-technical lens of the Activity Theory (e.g., the extended AT by Engestrom), has been mostly employed to study tensions, roles, and mediating artifacts in digital learning projects in order to provide explanatory force in the understanding of complex and context-dependent practices (Iyamu, 2019; recent applications to online learning settings 2023).

The framework of digital learning spaces developed by Dalsgaard (2023) also contributes to the theoretical arsenal by distinguishing between the space of individual learning, working group, community of interest, and open connection: it is important to remember that not all learning spaces can be served by the same pedagogical designs and technologies. These differences can be applied to map affordances and constraints of technologies to pedagogical aims.

Tool
Any material, medium, content, artefact, instrument, device and the like, that is used to mediate a learning process.

Subject
The subjects in a learning process are the learners.

Objective
In accordance with Bloom's taxonomy of educational objectives- knowledge, comprehension, applying, analyzing, synthesizing and creation.

Control (Rules)
The responsibility of the teacher or the learner for setting the right target and a meaningful process of learning.

Context (Community)
The relationship between the context of learning with the context of being, i.e. the environment of the learner.

Communication (Division of labor)
Learning is not an exclusively individual process; it usually includes social aspects.
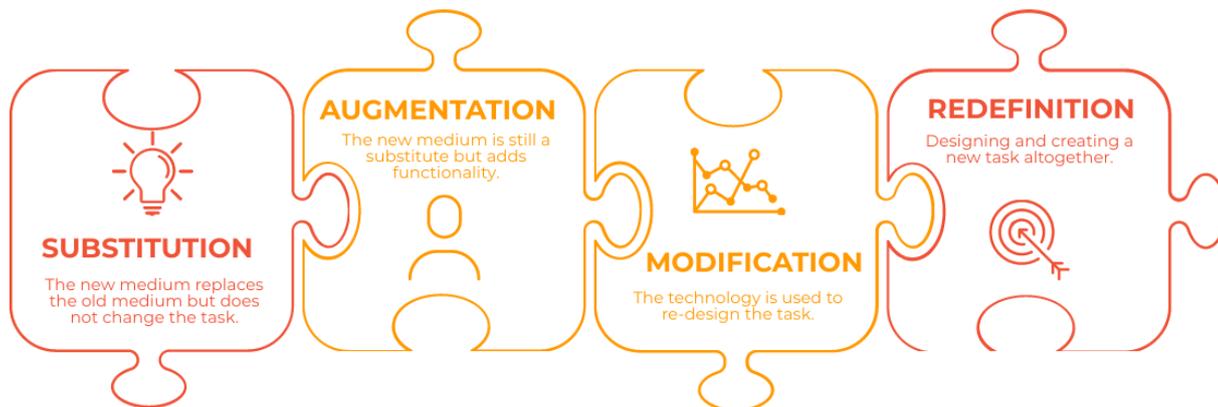
Activity theory for mobile learning (Khalil, 2019)

Learning Analytics Theory (Drachsler and Greller, 2011)
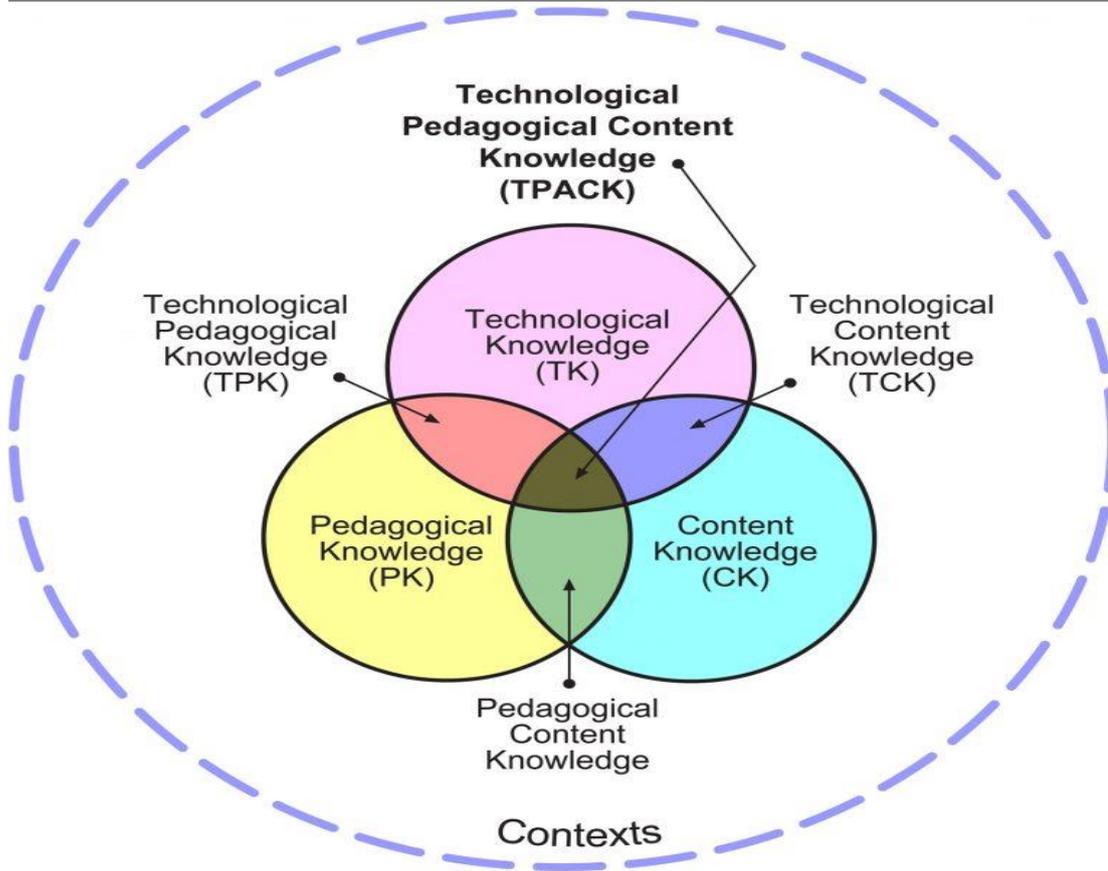
TPACK Model (Kurt, 2018)

The SAMR Model (Kurt, 2023)

LITERATURE REVIEW

Due to the spread of digital technologies in the educational sector, in their various manifestations; e learning, blended learning, social media-mediated learning, and online/distance education, there has been a resurgence of interest in the theoretical background that informs teaching and learning. Although the classical learning theories are still relevant, newer studies indicate the necessity to revise the frameworks and hybrid models that reflect the digital and networked learning conditions (Ahmad *et al.,* 2024; Mukhlis *et al.,* 2024).

This review is a survey comprising how the foundational theories (behaviourism, cognitivism, constructivism) still shape digital pedagogy, how newer theories (e.g. connectivism) have developed and how modern frameworks and empirical studies combine the perspectives to inform effective technology enhanced learning.

7. Traditional Theories in the Digital Context

The foundations of instructional design have always been behaviourism, cognitivism and constructivism. Observable responses, reinforcement, repetition are stressed in behaviourism the basics of early computer-assisted instruction and drill and practice systems. Even though these concepts were initially created without considering digital technology, they remain relevant to the areas of online learning, particularly the development of formative assessment and mastery learning through automated quizzes and adaptive systems (Ertmer and Newby, 2013; Ahmad *et al.,* 2024).

Cognitivism abandoned behavioural orientation and emphasised the internal mental processes: the way learners receive, process, store and retrieve information. In online learning, the principles of cognition have influenced the design of multimedia, interactive courses, and the sequence of information. As an illustration, cognitive load theory and the tenets of multimedia learning help designers of e learning materials to avoid overloading and improve understanding (Ahmad *et al.,* 2024). Cognitivism, therefore, is still at the focus of designing organized online courses and modules. Siemens (2004) explains that the information processing model of a computer is frequently adopted by Cognitivism. Learning is considered to be a process of inputs which is handled in the short-term memory and coded to be recalled in the long-term. Cindy Buell describes it as follows: Within the cognitive theories, knowledge is considered symbolic mental constructs in the mind of the learner, and the learning process is the mechanism through which these symbolical representations are encoded in memory. Constructivism together with its variations suggests that learning is participatory, socially mediated, and contextual as opposed to passive. Constructivist concepts in technology enhanced learning come in the form of collaborative activities, discussion forums, project-based learning, and learner centred activities (Ahmad *et al.,* 2024; Pratama *et al.,* 2025).

According to constructivism, learners develop knowledge in an endeavor to interpret their experience (Driscoll, 2000, p. 376). Behaviorism and cognitivism perceive knowledge as external to the learner and the process of learning as the internalization of knowledge. Constructivism presumes that students are not blank slates that are to be filled with knowledge. Rather, the learners are engaged in a process of trying to make meaning. Students tend to choose and take up their education. Constructivist principles recognize that messy and complex real-life learning takes place. Recent systematic review of online and hybrid learning conditions prior to and throughout COVID 19 identified constructivist pedagogy as very relevant: online learning encourages student centred, interactive and socially mediated knowledge building (Pratama *et al.,* 2025). Nonetheless, the review also points to the necessity of scaffolding, facilitation, and careful instructional design to prevent some traps like the isolation of a learner or shallow collaboration.

These results indicate that though the traditional theories were developed in pre digital environments, the principles underlying them can still be applicable - particularly with a deliberate modification to suit the opportunities and limitations of the digital world.

8. Emergence of Connectivism and Network-Oriented Theories

With the internet, Web 2 tools and global connectivity taking a central role in learning, scholars started to wonder whether classical theories were adequate in explaining the process of knowledge creation, sharing and sustenance in networked environments. In turn, there was the emergence of the learning theory of the digital age, the so-called Connectivism (Siemens, 2004). Connectivism argues that learning is based on networks, where the knowledge is spread among people, digital technologies, databases, and communities, and not on the mind of an individual (EdTech Books, n.d.; University of Queensland, 2021).

Connectivism, according to Siemens (2004) is the amalgamation of the concepts that are researched in the chaos, network and complexity and self-organization theories. The process of learning takes place in nebulous environments of changing core elements - not fully under the control of the individual. Learning (as actionable knowledge) may be external (within a company or a database), action oriented towards the linking of sets of specialized information, and connections that facilitate our learning are more significant than our present state of knowing.

Connectivist principles are up-to-date in the empirical research. As an example, in an article on online group work during the COVID 19 pandemic, online group learners have stated that diversity, openness, connectedness, and autonomy were positively related to their perception of online group learning (Fakir, Azman and Zahid, 2024). In the same vein, studies on digital pedagogy in Technical and Vocational Education and Training (TVET) settings discovered that blended learning, gamified learning, flipped classes, and adaptive pedagogies, which are guided by the concept of connectivism, increased the levels of learner autonomy, engagement, and collaboration (Chen and Chan, 2023). A more recent synthesis of theory goes further to spell out how connectivism can inform not only knowledge sharing but also lifelong learning and the acquisition of digital literacies (Mukhlis *et al.*, 2024).

Siemens (2004) also contributed that, Connectivism also tackles the issues faced by most corporations in their knowledge management exercises. The knowledge stored in a database should be linked to the appropriate individuals in the appropriate set-up to be considered as learning. Behaviorism, cognitivism, and constructivism make no effort to solve the problems of organizational knowledge and transference. The contribution of connectivism is not merely a conceptual one, but practical as well: connectivism redefines learning as dynamic, distributed and socially embedded by acknowledging the role of networks, social media and repositories as well as digital tools. The critics also note that it overlaps with current theories and has poorly defined borders (Goldie, 2016) however the tide of new empirical studies using the assumptions of connectivism is gaining traction (Ahmad *et al.,* 2024; Mukhlis *et al.,* 2024).

9. Contemporary Frameworks and Hybrid Models

In addition to connectivism, several current frameworks and hybrid models have emerged to mediate between theory and practice in technology enhanced learning. Others of these frameworks - including TPACK (Technological Pedagogical Content Knowledge) and SAMR (Substitution, Augmentation, Modification, Refinement) - have served as useful frames through which educators may synthesize technology and pedagogy and content, as well as a systematic way to adopt digital instructions (Blundell *et al.,* 2022; Dalsgaard, 2023).

A 2024 scoping review revealed that SAMR remains quite popular in educational research, albeit with incongruent definitions and applications (Blundell *et al.,* 2022). There is also the added level of learning analytics and data driven decision-making, which has brought up but one more; systems that combine data gathering, analysis and feedback to adapt learning and personalized instructions. Research indicates that learning analytics can be used to support early-warning mechanisms, enhance student retention, and allow timely interventions, yet they also bring up the issues of equity, privacy, and ethical practices (Khalil *et al.,* 2022; Banihashem *et al.,* 2022). Activity theoretic approaches, where aspects of learning, such as cultural, institutional and mediated by tools, are taken into account, have been exploited at a socio technical level to examine the intricate systems of blended learning and to understand how educational change is made within a context (Iyamu, 2019).

Further, new scholarship also covers the possible challenges and extensions of traditional and connectivist theories by AI, immersive environments (e.g., virtual physical "metaverse" classrooms), and generative technologies (Lin et al., 2022; Levin *et al.,* 2025). In a very recent review (Ahmad et al., 2024) of web-based learning studies done between 2020 and 2024, researchers still use an extensive range of theories to explain student engagement, satisfaction, knowledge construction and retention in online learning: cognitive, behavioural, social, constructivist, connectivism theories are all present. According to the authors, such plurality of theoretical frameworks is a manifestation of the multi-dimensional character of digital learning environments.

Therefore, the current research tendencies prefer to use multi theoretical and hybrid models: integrating classical theory of learning, connectivism, pedagogical frameworks and data-based design, implementation and evaluation of technology enhanced learning spaces.

10. Towards Synthesis: Theoretical Design towards Practice Hybrid models.

Synthesis is becoming more popular among designers and researchers due to the variety of different theories and frameworks that are relevant. A good technology-enhanced course could integrate behaviourist (automated formative quizzes), cognitivist (guided by multimedia modules) to decrease cognitive load and promote

understanding, constructivist (authentic tasks through project work) to facilitate application, CoI (informed by facilitating) to facilitate social and teaching presence, TPACK (guided by) teacher development to make successful integration, and learning analytics to keep track of engagement and make timely interventions (Zhang et al., 2023). Such mixed methods are endorsed by recent empirical research. Blended course studies indicate that CoI-based facilitation combined with analytics-informed instructor activities enhances persistence and learning outcomes; and studies on TPACK-informed professional development have demonstrated the importance of situating technology-based action to mediate pedagogical change. Activity-theoretic analyses at the systems level demonstrate the influence of institutional structures and regulations, along with role assignments, on the effectiveness of blended designs (Joshi, 2023).
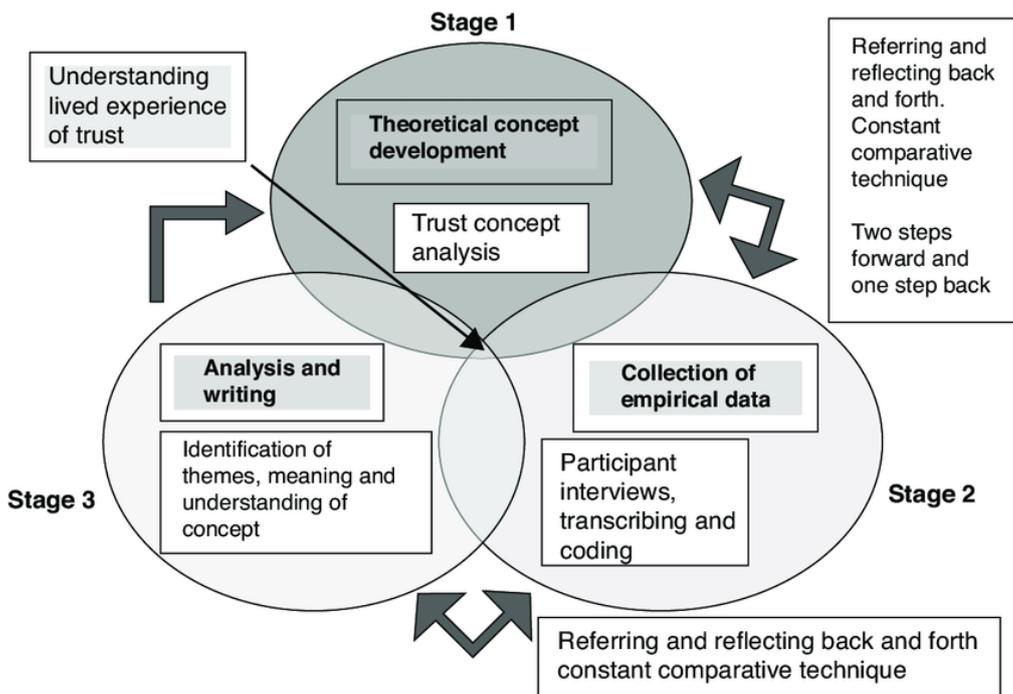
(Lewis et al., 2017)

11. Critiques, Challenges, and Gaps

Critiques, Challenges, and Gaps. Although the adoption of several theories is flexible and broad, it poses a challenge as well. Connectivism has an ambiguity in conceptual scope a few times - what is a network, how to measure learning, how to guarantee quality control and validation (Goldie, 2016; University of Queensland, 2021). In the same manner, the swift use of learning analytics and AI-based tools pose ethical, equity, and privacy issues (Khalil *et al.,* 2022).

Empirical reviews also observe that much research on social media-mediated or networked learning is based on technology acceptance models (e.g. TAM, UTAUT) rather than on educational theory (Social Constructivism, Connectivism), which suggests that there is still a theoretical gap in the basis of pedagogy (Systematic review of social media in higher education, 2023).

This implies that the equipment is improving, theoretical growth and instructional consideration are falling behind. Also, hybrid models although attractive demand an ardent instructional design, institutional sustenance, and situational sensitivity otherwise, efforts to blend several theories could result in coherent or piecemeal learning experiences.

12. Summary of Patterns in Recent Literature

Generally, it is possible to note that recent literature (2020-2025) demonstrates some significant trends:

a) Ongoing applicability of the traditional theories (behaviourism, cognitivism, constructivism) as purposefully applied to the digital environment.

b) The development of the theory of connectivism and network-based learning to explain the distribution of knowledge, social networks, and collaboration mediated by technology.

c) Development of pedagogical and practicum paradigms (TPACK, SAMR, learning analytics, activity theory, etc.) to inform design and implementation instead of just abstract knowledge.

d) More hybrid/ multi-theoretical intervention to capture the multi-layered reality and complexity of digital learning environments.

e) Expanding methodological diversity, such as design-based research, mixed-methods, analytics inspired evaluation, and socio-technical analysis.

f) Persistent gaps and issues - conceptual ambiguity, ethical issues, insufficient theoretical foundation of certain studies, and institutional capacity demands.

These trends indicate that the sphere of technology-enhanced learning is coming of age: the first experiments, which were often technologically oriented, were replaced by theoretically and context-sensitive studies and research-driven designs.

13. Implications for Research

The main implication to the practitioners is that intentional alignment: they have to select technologies based on their pedagogical purpose, not because they are new. TPACK-based training, practical SAMR-oriented lesson design exercises, and literacy in learning analytics reading should therefore be a part of the professional development.

To researchers, promising directions are to empirically test multi-theoretical designs in contexts, explore equity implications of analytics-based personalization, and explore the interaction between the emerging technologies (AI, AR/VR, multimodal analytics) and the theoretical constructs of presence, cognitive load, and networked learning.

Mixed-methods and design-based research designs are especially the most appropriate in researching context-sensitive and complex innovations of the digital learning process. The systems-thinking and the Activity Theory may assist the researchers in finding contradictions and leverage points of sustainable change.

14. Implications for Practice

1) **Design learning experiences that blend multiple theoretical perspectives:** The advantages of technology-enhanced environment include a deliberate blend of behaviourist strategies (e.g., automated feedback, reinforcement in the form of quizzes), cognitivist ones (e.g., scaffolding and control over cognitive load), and constructivist ones (e.g., problem-based learning). Teachers are not to stick to one paradigm but instead organize the instructional practices based on the learning outcomes, digital skills, and the readiness of learners.

2) **Leverage technology to facilitate adaptive and personalized learning:** Connectivist and modern data-driven methods emphasize the significance of student-directed learning and individualized trajectories. Educators can use analytics dashboards, adaptive learning platforms, and AI-powered recommendation systems to detect the needs of learners, ensure that they receive specific assistance, and enhance self-regulated learning.

3) **Encourage knowledge sharing and creation networks:** Connectivism emphasizes learning as a network building and network navigation process. The digital platforms that should be incorporated by teachers include: online discussion forums, collaborative documents, learning communities and social

media to support peer interaction, co-construction of knowledge and authentic involvement in broader professional or disciplinary networks.

4) **Develop digital literacy, critical thinking and knowledge-filtering skills:** With the growth of information, dissemination, and distribution, learners need to be educated about the ability to critically judge sources, to manage online identities and to be part of virtual communities in an ethical manner. These skills are the pillars of achievement in the technology mediated learning environments and correspond to the new post-connectivist views.

5) **Implement flexible, learner-centered pedagogies, which facilitate self-direction:** The heutagogical and rhizomatic learning orientations build up on the connectivist perspective and focus on the power of the learner, curiosity, and choice. In open and informal learning, practitioners are expected to create learning activities that provide learners with exploration, creativity, and objectives that are self-generated.

6) **Incorporate learning analytics to inform evidence-based instructional possibilities:** The combination of cognitive theories and technological environments that are rich in data promises the possibility of personalizing learning and improvement of feedback. Educators and institutions ought to acquire skills in analytics interpretation and apply to design better instruction, discover at-risk learners and enhance learning results.

7) **Consider digital learning design in terms of ethical, inclusivity, and accessibility:** With the spread of technological capabilities of learning, practitioners should make sure that digital ecosystems are fair and secure. This involves safeguarding their learner data, making it accessible to a wide range of learners (e.g. via the Universal Design for Learning principles), and making digital tools accessible to all students in order to meaningfully engage with them despite their socioeconomic status or ability.

8) **Prepare teachers for evolving practices in technologies-based settings:** The transition into a networked, collaborative, and AI-assisted learning needs lifelong learning. Teachers must not only be trained on the digital tools but they should be also trained on the theoretical backgrounds which will lead to a good use of technology so that technology is not used in a superficial manner.

CONCLUSION

The history of behaviourism to cognitivism, constructivism and finally, connectivism is the result of the dynamic interrelationship between learning theories and the technological development. Both theoretical paradigms have provided some useful information on the acquisition, processing, and application of knowledge by learners. The adherents of behaviourism focused on observable change and reinforcement, cognitivism cast focus on internal mental aspects underlying learning, constructivism brought an emphasis on agency of the learner, pre-existing knowledge, and the creation of meaning to learning processes, and the connectivist brought into the discussion the impact of networks, digital technology, and the distributed knowledge system on learning in the modern environment.

There is no individual theory in technology enhanced education that works alone. Rather, the contemporary situation requires a holistic, dynamic solution that taps the strengths of either theory based on the situation, needs of the learners and the aims of the learning. Educators are now obliged to promote personalised ways of learning, collective knowledge construction, and assist learners to navigate the vast and swiftly changing sources of information in digital learning spaces. Increasingly fluid, self-organized, data-driven, and network-mediated learning in emerging frameworks like rhizomatic learning, heutagogy and learning analytics-informed pedagogies, the 21st century suggests that learning is becoming more fluid, self-directed, data-driven and network-mediated. With the continuing technological revolution in the context of educational practice, research and pedagogical practice in the future needs to extend beyond connectivism to include AI-based learning systems, human-machine interaction, adaptive systems and ethical issues in data-rich contexts.

In sum, the development of learning theories can prove that effective technology-enhanced education is not based on the technological newness but on profound and transforming insights on human cognition of learning.

Through the incorporation of the classical and emerging approaches, teachers can create learning opportunities that are technologically suitable, as well as sound pedagogically, inclusive, and future-oriented.

REFERENCES

1. Ahmad, A. R., Ali, D. F., Wahab, N. A., Kamaruzaman, N., & Othman, N. F. (2024). Exploring learning theory usage in web-based learning: A comprehensive literature review. International Journal of Academic Research in Progressive Education and Development, 13(4), 1983–1994. https://doi.org/10.46886/IJARPED/v13-i4/18981
2. Banihashem, S. K., et al. (2022). A systematic review of the role of learning analytics in enhancing feedback practices in higher education. Computers & Education: Artificial Intelligence.
3. Bates, T. (2019). Teaching in a digital age: Guidelines for designing teaching and learning. Tony Bates Associates.
4. Blundell, C. N., et al. (2022). A scoping review of the application of the SAMR model in educational research. Computers & Education: X.
5. Bozkurt, A., Honeychurch, S., Caines, A., & Bali, M. (2016). Community tracking in a cMOOC and nomadic learner behavior identification on a connectivist rhizomatic learning network. Turkish Online Journal of Distance Education, 17(4), 4–30. https://doi.org/10.17718/tojde.09231
6. Chen, X., & Chan, S. (2023). Implementing digital pedagogy in TVET: A Connectivist perspective. Vocational & Technical Education Journal.
7. Chuane Q (2025). Conceptual framework of applying CoI-based blended learning approach to enhance students' vocabulary and vocabulary learning motivation. PLoS One. 2025 Aug 12;20(8): e0330115. doi: 10.1371/journal.pone.0330115. PMID: 40794725; PMCID: PMC12342318.
8. Cormier, D. (2008). Rhizomatic education: Community as curriculum. (Blog/essay).
9. Dalsgaard, C. (2023). A theoretical framework for digital learning spaces. Research in Learning Technology.
10. Drachsler, H., & Greller, W. (2011). The pulse of learning analytics: Understandings and expectations from the stakeholders. In Proceedings of the Learning Analytics and Knowledge Conference (pp. –). https://doi.org/10.1145/2330601.2330634
11. Du-Preez, I., & Jacobs, L. (2025). Pedagogical and visual design principles for online learning material: Insights from quality guiding documents in diverse educational contexts. Interactive Learning Environments. Advance online publication. https://doi.org/10.1080/10494820.2025.2523390
12. Ertmer, P. A., & Newby, T. J. (2013). Behaviorism, cognitivism, constructivism: Comparing critical features from an instructional design perspective. Performance Improvement Quarterly, 26(2), 43–71. (Foundational synthesis still cited in recent reviews)
13. Fakir, M. S. B., Azman, H. A. B., & Zahid, A. Z. B. M. (2024). Exploring online group work through Connectivism theory. International Journal of Academic Research in Business and Social Sciences, 14(8).
14. Gagné, R. M. (1985). The conditions of learning (4th ed.). Holt, Rinehart and Winston.
15. Garrison, D. R., Anderson, T., & Archer, W. (2000). Critical inquiry in a text-based environment: Computer conferencing in higher education. The Internet and Higher Education, 2(2–3), 87–105.
16. Iyamu, T. (2019). The use of Activity Theory to guide information systems research. Education and Information Technologies. (Used by more recent studies examining socio-technical contexts of digital learning)
17. Jonassen, D. H. (1999). Designing constructivist learning environments. In C. Reigeluth (Ed.), Instructional-design theories and models (Vol. 2, pp. 215–239). Lawrence Erlbaum. (Classic, cited in modern digital pedagogy reviews)
18. Joshi, S. (2023). TPACK and teachers' self-efficacy: A systematic review. Canadian Journal of Learning and Technology. (CJLT)
19. Khalil, M., et al. (2022). Learning analytics frameworks: mapping current practice and challenges. ACM Computing Surveys / Proceedings.
20. Khalil, F. (2019). Experimental review of mobile learning technology research: Activity Theory framework (2014–2019). Global Journal of Emerging Sciences, 1(4), 302–320. https://doi.org/10.37187/gjoes.1219.0104.02

21. Kholid, M. N., et al. (2023). A systematic literature review of TPACK in subject domains. Cogent Education.
22. Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why minimal guidance during instruction does not work. Educational Psychologist, 41(2), 75–86.
23. Kop, R., & Hill, A. (2008). Connectivism: Learning theory of the future or vestige of the past? International Review of Research in Open and Distance Learning, 9(3), 1–13.
24. Kurt, S. (2023, September 20). SAMR model: Substitution, augmentation, modification, and redefinition. https://educationaltechnology.net/samr-model-substitution-augmentation modification-and-redefinition/
25. Kurt, S. (2018). TPACK: Technological Pedagogical Content Knowledge framework (updated September 16, 2019). https://educationaltechnology.net/technological-pedagogical content-knowledge-tpack-framework/
26. Levin, D., Semenov, A., & Gorsky, P. (2025). AI-assisted adaptive learning in higher education:Opportunities and challenges. Journal of Educational Technology & Society, 28(1), 4562.
27. Lewis, M., Jones, A., & Hunter, B. (2017). Women's experience of trust within the midwife mother relationship. International Journal of Childbirth, 7(1), 40–52.https://doi.org/10.1891/2156-5287.7.1.40
28. Mayer, R. E. (2009). Multimedia learning (2nd ed.). Cambridge University Press.
29. Mukhlis, H., Haenilah, E. Y., Sunyono, S., Maulina, D., & et al. (2024). Connectivism and digital age education: Insights, challenges, and future directions. Kasetsart Journal of Social Sciences, 45(3), 803–814.
30. Pratama, F. R., Santoso, H. B., Junus, K., & et al. (2025). Constructivism in online and hybridlearning before and after COVID-19: A systematic literature review. Jurnal EduScience, 12(4), 1111–1129.
31. Shea, P., & Bidjerano, T. (2010). Learning presence: Towards a theory of self-efficacy, selfregulation, and the development of communities of inquiry in online and blended learning environments. Computers & Education, 55(4), 1721–1731.
32. Siemens, G. (2005). Connectivism: A learning theory for the digital age. International Journal ofInstructional Technology and Distance Learning, 2(1), 3–10.
33. Skinner, B. F. (1968). The technology of teaching. Appleton-Century-Crofts.
34. University of Queensland, Institute for Teaching and Learning Innovation. (2021). Learningtheories and frameworks for digital learning. (Overview of connectivism and other theories in networked learning contexts). (UQ Teaching & Learning Innovation)
35. Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes. Harvard University Press.
36. Zhang, Y., et al. (2023). Investigating the impact of the Community of Inquiry framework onstudent online learning outcomes. Online Learning Journal.
37. Declaration: Generative AI was used in some analysis and was also used to enhance the structure of the write-up.