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Artificial Intelligence as a Mediational Tool: Reinterpreting Vygotsky's Zone of Proximal Development in AI-Assisted Learning

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Abstract:
This study deliberately and critically explores the integration of Artificial Intelligence within educational field through the lens of socio-cultural theory by Lev Vygotsky. This study has given special focus on the Zone of Proximal Development or ZPD. It tries to evident AI as a mediational tool that redesigns scaffolding, learner regulation, feedback and extends the scope of the ZPD beyond traditional human interactions model. The research explores how AI supports learners in tasks they cannot complete independently but can achieve with guided support through adaptive algorithmic scaffolding and feedback. By imagining Vygotskian principles with AI-driven educational tools in contemporary world the study emphasizes AI and its role in promoting cognitive development while taking care of its limitations in terms of ethical judgment and cultural intentionality. A socio-technological framework is proposed that integrates human mediation, assistance of AI, and learner agency within a dynamic ZPD.

Keywords: Artificial Intelligence in Education, Zone of Proximal Development (ZPD), Socio-cultural Theory, AI Mediation, Scaffolding, Vygotsky, Socio-technological Learning

1.0. Introduction

The Socio-cultural theory of Lev Vygotsky defines learning as a process that is mediated by society. Learning shaped by interaction between language and cultural tools. According to Lev Vygotsky, at the social level higher mental functions first develop and later become internalized at personal level. Through guided participation cognitive growth develops. The Zone of Proximal Development can be said as distance between what a learner can do independently and what can be accomplished with help of a more knowledgeable other (Vygotsky, 1978). Therefore mediation acts as the main system that changes the external interaction into internal rationale. Artificial intelligence has expanded widely particularly within educational context. Tools such as Khanmigo and ChatGPT now provide automated feedback, adaptive tutoring and dialogic assistance. AI based systems increasingly bring dynamism in instruction, assessment and academic research (UNESCO, 2023). Here learner inputs are responded dynamically to generate model reasoning steps, hints and simulate conversational scaffolding for the students. As a result, algorithmic mediation is introduced into spaces traditionally structured by teachers. The theoretical grounding of AI in education however remains limited. Personalization, efficiency and data analytics lacks engagement with foundational learning theory. AI should be understood as a socio-technical artifact added within cultural practice not mere as a neutral instructional mechanism (Holmes et al., 2022). From socio-cultural view tools reframe cognition by organizing participation and problem

solving processes. Educational technology frequently defines AI as intelligent tutoring without examining whether its guidance link with Vygotskian concept of scaffolding and co-construction. Questions remain unanswered regarding whether AI positively extends the learner's Zone of Proximal Development or simply automates responses only. A theoretical reinterpretation is necessary to clarify these differences.

The study purposes to reinterpret the Zone of Proximal Development within AI assisted learning. It places artificial intelligence as a mediational tool that reorganizes feedback, scaffolding and learner regulation. Based on AI integration within socio-cultural theory this framework gives conceptual clarity for evaluating its developmental potential and limitations in contemporary system of education.

2.0. Core Concepts of Vygotskian Theory

Lev Vygotsky proposed that through the mediation cognitive development of the child originates with the help of social interaction with language and various cultural tools. Higher mental functions emerge in public interaction then become internalized within self. The Zone of Proximal Development clarify the idea that how temporary support activates learner's capacity to accomplish beyond independent performance, highlighting central mechanisms of learning like mediation and scaffolding (Vygotsky, 1978).

Zone of Proximal Development.

The idea of ZPD or the zone of proximal development was produced by Lev Vygotsky in the late 1920s and further refined until his death in 1934. Vygotsky described the ZPD as the gap between what a learner can do independently and what the learner can achieve with guidance from an adult or in cooperation with a more knowledge peer. In simple terms it spots the difference between the present level of development of the learner and the higher level of development that becomes possible after the social interaction and the use of psychological and cultural tools. Vygotsky believes that learning takes place in collaborative settings in most effective manner. When learners engage in conversation with someone more skilled they gradually absorb and accommodate new concepts and strategies. Roosevelt (2008) explains that from a Vygotskian point of view, education should always position the learners within their Zone of Proximal Development. Teachers roles are to provide new tasks that are meaningful, relevant and slightly beyond the learner's independent ability for which support becomes necessary. After students completing such tasks together with teachers they can often perform them alone independency. This progression pattern expands their developmental level and the cycle continues with more advanced tasks.

Figure - 1 Illustration of the zone of proximal development (Wikimedia Commons, 2014)

More Knowledgeable Other.

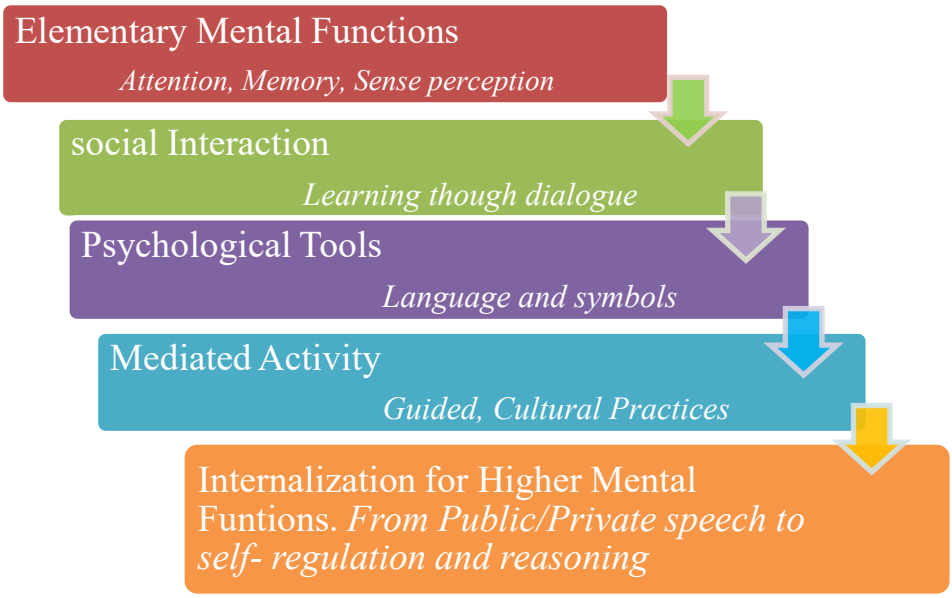
More Knowledgeable Other, commonly termed MKO is introduced by Lev Vygotsky. This concept is placed within the broader design of his socio-cultural theory of development. Based on the core theory, MKO means an individual who equipped with a higher level of skill, knowledge or understanding. An MKO contain knowledge in relation to a specific activity and supports the development of students through guided interaction and support. This guidance works within the Zone of Proximal Development where learning occurs through mediated assistance and collaboration (Vygotsky, 1978). The MKO may be anyone teacher, peer or competent adult who structures tasks, provides hands and gradually withdraws his supportive hands as competence of the learner increases. Through such mediated participation learners internalize strategies and develop conceptual understanding along with transforming socially shared activity into independent cognitive functioning (Vygotsky, 1978).

Mediation

Lev Vygotsky states the concept of mediation. The human cognition develops through some media which is culturally created tools especially language and signs. Through symbolic systems Individuals engage with reality that ultimately shape thinking and action ability. At first Higher mental functions develop in social interaction and become internalized later by the students as individual processes. Mediation transforms natural capacities into culturally organized psychological functions (Vygotsky, 1978; Cole, 1996).

The foundation of the developmental theory of Lev vygotsky rests on the view that psychological tools mediate elementary mental functions (Vygotsky, 1966; Wertsch, 1985). He insists that higher mental functions develop through some mediated activity socio-culturally created where psychological tools and the social interaction shape cognitive domain and transform natural processes into culturally organized forms of thinking and reasoning (Kozulin, 1990).

Figure 2: Conceptual Flow of Mediation in Theory of Cognitive Development by Lev Vygotsky



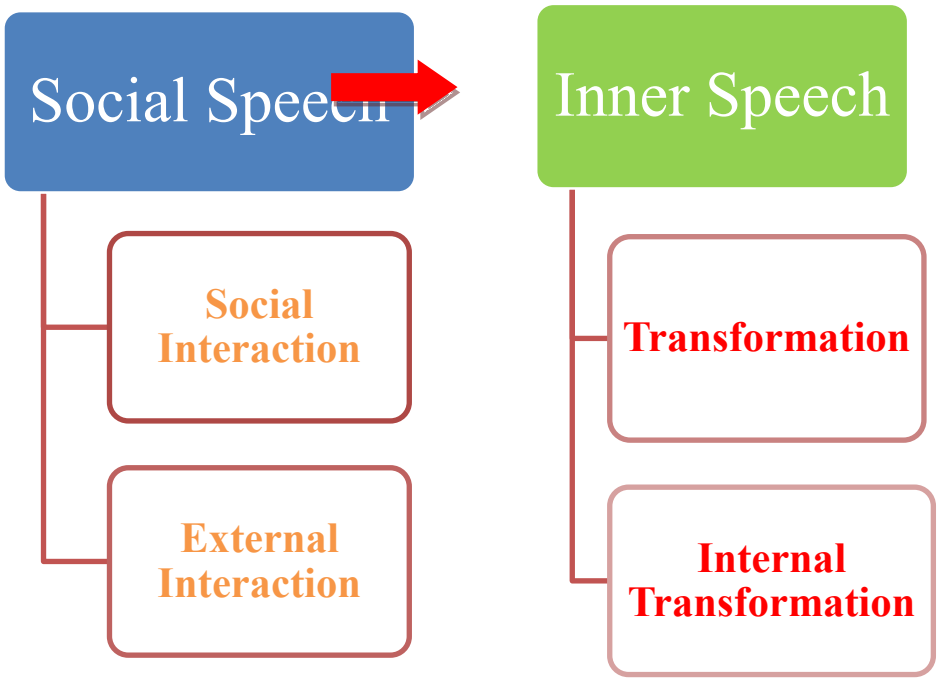
Just like how material tools are created by society, psychological tools are also socially constructed. Material tools deal with external world and regulate interaction with the external circumstances but psychological tools regulate thought and behavior internally. These types of tools are internally directed and largely symbolic. They basically are transforming natural abilities into higher psychological

processes (Kozulin, 1988). Vygotsky also stressed on various semiotic types of mediators from simple signs to complex type of symbolic forms such as literature etc. These tools function as psychological tools in converting natural impulses into advanced mental functions (Kozulin, 1990).

Language and internalization.

The concept of Language in Lev Vygotsky theory is the primary psychological tool that mediates the process of thinking, thought and social interaction. It originates first as social speech and later changes into inner speech. It shapes the higher mental functions. Here in this process Internalization means the process by which external social behaviors and dialogues transform into intrinsic cognitive processes. Through this transformation, the conversion of interpersonal experiences into intrapersonal thinking articulated by the learner.

Figure 3: Language as a mediator in Lev ygotsky theory



3.0. AI as a Mediational in Learning

By providing adaptive feedback and scaffolding within the learner's Zone of Proximal Development, Artificial intelligence can act as a means or channel of students learning. It supports tasks learners cannot do independently but can accomplish with guided support by other. AI-mediated assistance has been shown to enhance learner participation, provide personalized scaffolds and function as a culturally embedded tool that promote cognitive growth in line with socio-cultural theory (Cai et al., 2024)

- AI can perform as mediational support with structured scaffolding within the Zone of Proximal Development of the students. AI tutoring systems with adaptive guidance improves learning through step by step support and feedback. This is grounded with socio-cultural mediation principles.
- Language based interaction promotes the domain of cognitive development with the help of dialogue and explanation. Empirical studies on ChatGPT in education found that it supports learning through conversational feedback along with idea generation and academic assistance in higher education contexts (Rudolph, Tan, & Tan, 2023). This matches with the principles of language as a psychological tool in learning (Vygotsky, 1978).

- Immediate formative feedback stimulates learning by guiding revision and self regulation. Grammarly in this context provides real time corrections in grammar, structure and clarity. Instant and effective feedback is a key factor of achievement and supports internalization of skills.
- Individual progress through personalized learning platforms, support adaptive practice. Duolingo adjusts tasks according to learner performance promoting mastery at appropriate levels of difficulty. Adaptive systems have been shown to improve learning outcomes with the help of tailored instruction.
- Guided problem solving in mathematics becomes more effective if learners receive structured hints and corrective feedback tools. MATHia by Carnegie Learning stands as an intelligent tutoring platform that supports stepwise reasoning. Intelligent tutoring systems enhance achievement in compared to conventional instruction.

4.0. Reconceptualizing the Zone of Proximal Development in AI Mediated learning

The inter-link of AI into education requires a critical synthesis about the Zone of Proximal Development. The framework of AI as mediation tends to elaborate the nature of scaffolding. guidance and internalization. The following analytical questions and theoretical responses clarify how Vygotskian principles emerge within the context of socio-technological learning.

Table 1: Analytical Questions and Responses on ZPD and AI Mediated Learning

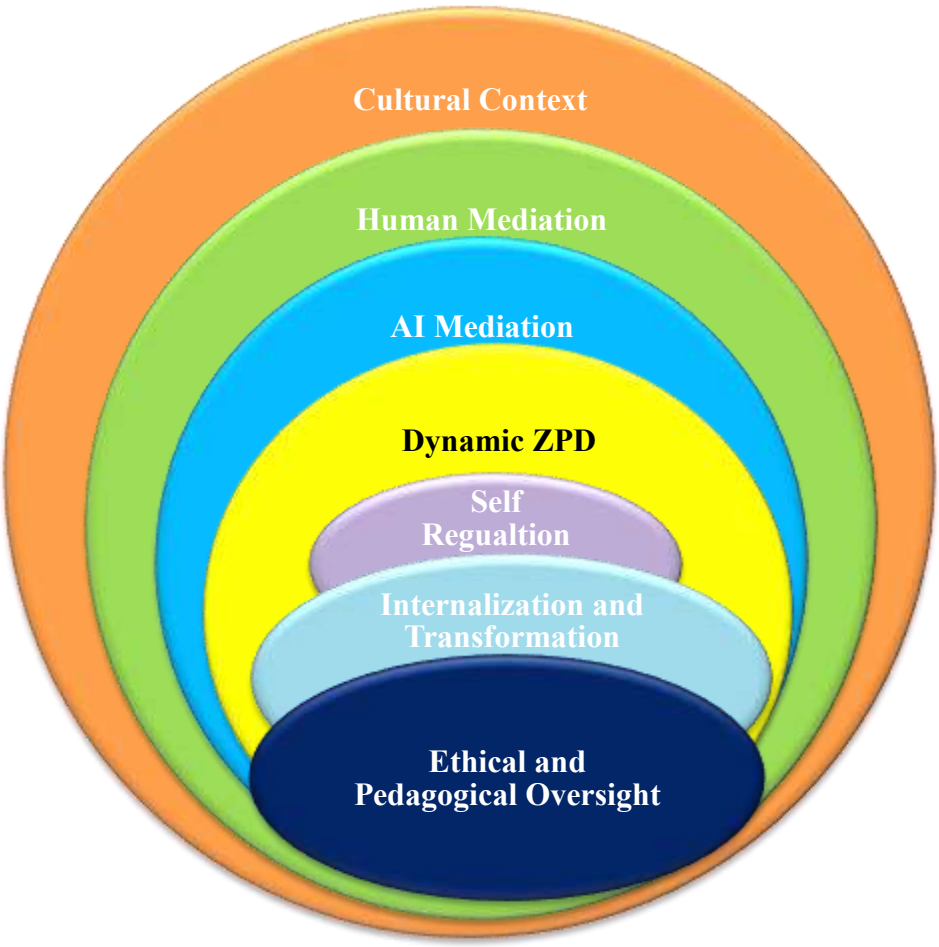
Analytical Questions.	Theoretical Reflection
In what context AI mediated learning environments explain the scope of the ZPD?	AI expands the role of the MKO by providing adaptive prompts, feedback and reasoning. It changes mediation from exclusively human interaction to hybrid human AI support while retaining the core essence of scaffolded assistance.
To what extent can AI be named as a digital MKO?	AI can simulate aspects of the MKO by offering domain specific explanations and stepwise hints. However it operates through algorithmic prediction which distinguishes it from human mediation.
Does AI mediated learning suggest a shift from socio-cultural to socio technological theory?	The ZPD becomes a dynamic space shaped by human guidance, algorithmic and scaffolding. This reframes mediation as socio-technological rather than purely interpersonal
What implications for the process of internalization does AI mediation have?	AI may accelerate internalization by activating instant clarification and repeated guided practice. However internalization still depends on active learner engagement, reflection and meaningful social involvement.
Does algorithmic scaffolding transform the nature of mediated activity?	AI assists with immediate data driven and individualized feedback at scale. Teacher scaffolding includes contextual judgment, emotional sensitivity and cultural responsiveness. AI supports cognitive structure, while teachers integrate cognitive and socio emotional mediation.

AI mediated learning does not replace Vygotskian basic theory but It expand them. ZPD now operates within a socio technological framework where digital scaffolding and human guidance interact. Critical reflection on agency and internalization mechanism needed for such shifts. The future of mediation depends on how systematically AI is integrated into pedagogical practice.

5.0. Socio Technological Framework

Socio Technological Learning design explained as a theoretical model that define learning as a mediated process. Learning occurs through the interaction of cultural tools, human guidance and technologies within a dynamic ZPD.

Figure 3: Socio-Technological Learning Based on Socio-cultural theory



This framework expands the socio-cultural theory of Vygotsky by placing AI as a digital psychological tool that assist scaffolding mechanism with feedback and regulation. Learning takes place through structured interaction among human mediation, algorithmic mediation and learner agency. The Zone of Proximal Development becomes a fluid space of socio-technology where guidance is co-constructed by the teachers and artificial intelligent. Internalization associated with externally supported activity that transforms into higher cognitive functioning through self regulation.

6.0. Conclusion

Re-interpretation of Vygotsky's ZPD in AI enabled learning system critically reevaluates mediation in

present system of education. The study strongly believes that AI does not take the socio-cultural foundations of Vygotsky. It may extend them into digitally structured learning domains. Through dialogic prompting, adaptive feedback and personalized scaffolding mechanism AI strengthen the operational scope of the Zone of Proximal Development. The ZPD originates as a dynamic recalibrated space shaped by student involvement with both human guidance and intelligent innovations. Also the study acknowledges conceptual limitations. AI performs as an instrumental and algorithmic mediator. Here cultural intentionality lacks along with ethical judgment and lived social experience. Human remain central to meaning, formation of values and reflective engagement. Internalization requires conscious participation and dialogic depth that cannot be automated. A socio technological framework is reinterpreted from ZPD within where agency, pedagogy and computation intersect. This concludes that the future of AI assisted learning depends on critical design with ethical oversight and pedagogical intentionality. When thoughtfully and deliberately integrated AI can strengthen mediated learning while preserving the essence of human core education.

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