Revisiting Knowles' "Self-Directed Learning" Theory in the Age of AIGC: A Conceptual Reconstruction Based on the Relationship Between "Technological Dependence" and "Learner Autonomy" in Adult Learners with Disabilities

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Abstract

The deep integration of AIGC technology into adult education for persons with disabilities raises a fundamental question: can technological dependence and learner autonomy coexist? This study examines the explanatory power of Knowles' self-directed learning theory for adult learning among persons with disabilities through proposition deduction and conceptual reconstruction. Findings indicate that the core logic of Knowles' theory - learner-centered agency - remains valid despite technological intervention. This is because psychological maturity and experiential accumulation, the prerequisites for self-directed learning, function independently of physical ability. However, the implementation pathway requires modification: from unmediated autonomy to technology-mediated autonomy. For persons with disabilities, reliance on AIGC tools constitutes functional dependence. This mechanism empowers learners to transcend physical limitations and secures their right to participate, forming a synergistic rather than antagonistic relationship with learner autonomy. Technology enables learning access while learners determine what to learn, how to learn, and how to evaluate outcomes. Accordingly, this study constructs a three-tier analytical framework: the functional tier addresses participation access, the mechanism tier ensures technology serves learner goals, and the value tier orients toward the integration of inclusive learning and self-actualization. This study transcends the historical limitations of Knowles' technology-absent theoretical context, resolves scholarly debates regarding whether technological dependence undermines learner autonomy through a typological distinction between functional and alienating dependence, and provides theoretical guidance for technology design and educational practice in AIGC-era adult education for persons with disabilities.

1. Introduction

Malcolm Knowles' theory of self-directed learning posits that adult learners possess the psychological maturity to transition from teacher-directed to self-directed learning (Knowles, 1975). According to Knowles, self-directed learning is the process by which individuals proactively diagnose their learning needs, set learning goals, identify learning resources, select and implement appropriate strategies, and evaluate learning outcomes - with or without external support from teachers, experts, peers, and learning materials (Ling, 2017; Zhu & Xu, 2020). By establishing learner ownership of this complete cycle as the essential characteristic distinguishing adult learning from child learning, Knowles created the theoretical cornerstone of the learner-centered paradigm in adult education. However, when applied to adult education for persons with disabilities, Knowles' theory encounters explanatory limitations. Persons with disabilities face distinct physical limitations: visually impaired individuals may not access text directly, hearing impaired learners may face barriers in discussions, and physically impaired learners may struggle to operate equipment. Consequently, they must use assistive technologies to participate in learning. In the era of Artificial Intelligence Generated Content (AIGC), intelligent tools such as screen readers, real-time captions, and voice input have achieved a qualitative leap in accuracy, interactivity, and scenario adaptability by leveraging generative AI technology, providing unprecedented technological support for people with disabilities to overcome physical barriers. This technological mediation raises a fundamental theoretical question: does the dependence of persons with disabilities on AIGC tools erode learner autonomy, or does it constitute a necessary condition for learner autonomy to be realized? Knowles'theory, developed in a pre-digital context, assumed learners possessed unmediated access to learning materials - an assumption that does not hold for persons with disabilities who require assistive technology to access text, participate in discussions, or manipulate learning tools. Knowles' developmental model posits a linear progression from dependence to autonomy. However, this model struggles to explain how technological dependence and learner autonomy can coexist in disability education.

Existing scholarship offers contradictory positions on technology's role in learner autonomy. Technology empowerment theorists argue that AIGC tools strengthen autonomy by lowering participation barriers (Dai & Wang, 2025). In contrast, alienation theorists worry that algorithmic mediation replaces learner judgment, creating technology-directed rather than self-directed learning (Liu, 2024). However, both positions overlook a crucial distinction: for persons with disabilities, technological dependence is not a choice but a structural necessity arising from physiological constraints. This oversight reveals a fundamental gap in existing scholarship. The central theoretical question therefore becomes: does technology-mediated access undermine or enable learner autonomy? This study argues that the answer depends on the type of technological dependence involved. When AIGC tools function as access mechanisms that preserve learner control over goal-setting, resource evaluation, and outcome assessment, they constitute

functional dependence that enables rather than erodes autonomy. This distinction resolves the apparent contradiction between technological dependence and learner autonomy in disability education. The study thus makes two contributions: theoretically, it extends Knowles' framework to technology-mediated learning contexts by distinguishing functional from alienating dependence; practically, it provides design principles for AIGC accessibility tools that prioritize learner agency over algorithmic efficiency. By resolving the apparent tension between technological dependence and learner autonomy, this framework enables educators and designers to support genuine self-directed learning while acknowledging the structural necessity of technological mediation for persons with disabilities.

2. The Theoretical Foundations and Conceptual Boundaries of Knowles' Self-Directed Learning Theory

2.1. Theoretical Origins and Evolution Trajectory

Self-directed learning originated in early 20th-century adult education thought (Shen, 2017). Lindeman (1926) first positioned learner agency at the center of the field, emphasizing that adult learning should be rooted in life experience and guided by problem-solving. While Houle (1961) formally introduced the term into academic discourse, it was Tough's (1979) empirical research on "learning projects" that revealed adults actively plan and implement learning in daily life, providing the empirical foundation for Knowles' theoretical constructs. Knowles systematized this theory in Self-Directed Learning: A Guide for Learners and Teachers (1975), though he later refined his views in 1980 to view adult and child education as a continuous spectrum rather than a binary opposition (He & He, 2022).

Philosophically, research has evolved through three paradigms: progressivism, humanism, and constructivism.

a. The Progressivist approach focuses on observable behavior. Knowles' process model exemplifies this, defining self-directed learning as a linear sequence of steps (diagnosing, planning, evaluating) (Zhu & Xu, 2020).

b. The Humanistic approach emphasizes self-actualization, positing that individuals possess innate drives toward self-responsibility. However, this view often isolates the learner from their environment.

c. The Constructivist approach examines learning within a social context, viewing it as an interactive construction between learners and their environment.

This evolution reflects a deepening understanding of learner agency: shifting from behavioral description (progressivism), to internal motivation (humanism), and finally to socially situated agency (constructivism).

2.2. Conceptual Meanings and Underlying Assumptions

Knowles defined self-directed learning as a process in which individuals take the initiative - with or without the help of others - to diagnose their learning needs, formulate goals, identify resources, select strategies, and evaluate outcomes (Zhang, 2017). This definition encompasses three levels of meaning: first, the initiative to initiate learning belongs to the learner; it is the

learner, not the teacher, who decides what to learn, why to learn it, and how to learn it; second, the control over the learning process belongs to the learner, with the learner having complete control over resource selection, strategy adjustments, and progress monitoring; and third, the authority to evaluate learning outcomes belongs to the learner, who assesses the effectiveness of their learning based on their own set goals. It is essential to clarify that self-directed learning is not a solitary endeavor devoid of external support. Effective self-directed learning involves the learner's process of acquiring and processing information from teachers, experts, peers, learning materials, and various resources, which is a form of conditional learning. This clarification holds dual theoretical significance. First, it corrects the narrow understanding of self-directed learning as equivalent to independent learning. Second, it establishes technology as a legitimate external resource in self-directed learning - a point particularly relevant to AIGC tools, which function as novel learning resources that learners actively integrate rather than passively consume.

Knowles' theory rests on five fundamental assumptions distinguishing adult learners from children:

a. Self-concept evolution: Adult learners possess a distinct self-concept that enables them to guide their own learning. As individuals mature, their self-concept evolves from dependence to autonomy, creating the psychological foundation for self-directed learning.

b. Experiential resource base: Adult learners have accumulated extensive life experiences that serve as both a repository of learning resources and a framework that shapes their learning styles and cognitive schemas. This experiential base distinguishes adult learning from the relatively limited experience foundation of childhood education.

c. Role-based readiness: An adult learner's readiness for learning is closely tied to their social roles. Career development, family responsibilities, and social involvement trigger learning motivation in ways that differ fundamentally from the externally imposed curricula of childhood education.

d. Problem-centered orientation: Adult learners approach learning with a problem-centered rather than discipline-centered mindset, focusing on immediate application of knowledge rather than deferred application. This pragmatic orientation reflects their need to address real-world challenges in their professional and personal lives.

e. Internal motivation primacy: The primary driving force behind adult learning stems from internal factors such as self-esteem enhancement, quality of life improvement, career fulfillment, and self-actualization, rather than external rewards or punishments that typically motivate child learners.

Collectively, these assumptions posit that psychological maturity and accumulated experience - rather than physical capacity - provide the internal basis for self-directed learning.

Here, a clarification of a viewpoint is required: in the field of self-directed learning research, the academic community has long held the view that learner autonomy is best realized through the minimization of external mediation, with this view assuming that reduced reliance on external agents strengthens' self-regulatory capacity. However, such an assumption presupposes unimpeded access to learning environments.

For adult learners with disabilities, this presupposition does not hold. In contexts where access to texts, interaction, and learning tools depends on assistive technologies, technological mediation is not a contingent pedagogical choice but a structural precondition for participation. The absence of mediation does not signify autonomy but exclusion. Consequently, technological mediation does not undermine self-directed learning in disability contexts; it constitutes the condition through which learner agency can be enacted.

2.3. Theoretical Expansion and Academic Inquiry

Subsequent scholarship has expanded Knowles' framework in three directions: operationalizing self-directed learning through practical tools, incorporating metacognitive dimensions absent in Knowles' behavioral focus, and recognizing developmental variability in self-directed capacity. Allen Tough introduced the concept of a learning contract, defining it as a bilateral agreement between students and educators to achieve certain standards during the learning process. This acknowledges students' ability to be self-reliant and manage their own performance, providing a practical tool for self-directed learning. Garrison (1997) constructed a comprehensive model comprising self-management, self-monitoring, and motivation as three dimensions, arguing that meaningful and valuable learning must view external task control and cognitive responsibility issues as a unified whole. This overcomes Knowles' limitations in focusing solely on explicit process descriptions by incorporating the meta-cognitive dimension into the analytical framework. Grow (1991) proposed a four-stage development model: dependent, interested, participatory, and autonomous, emphasizing that self-directed abilities are not static traits but rather developing tendencies. This gradual development is a synthesis of personality traits and situational responses, offering a tool for understanding the diverse needs of learners at different stages of development. More recent research has further introduced the concept of deep self-directed learning, which refers to the process of learners critically incorporating new knowledge and ideas into their existing cognitive structures while understanding the knowledge, applying it in new problem-solving contexts, and thereby elevating self-directed learning from superficial information acquisition to deep meaning construction. Recent research within the Chinese context has also analyzed ability structures, breaking down self-directed learning abilities into dimensions such as learning motivation and attitude, formulating and executing learning plans, self-regulation, and interpersonal communication and cooperation. This provides an operational framework for measuring and cultivating self-directed learning abilities. However, none of these expansions address how technological mediation fundamentally alters the premises of self-directed learning - particularly for learners whose access to learning materials requires assistive technology as a structural precondition rather than an optional resource.

Despite these expansions, three persistent critiques challenge Knowles' framework. Firstly, cultural bias critiques argue that Knowles' assumptions about adult education may reflect the learning preferences and value orientations of the Western middle class, and their cross-cultural applicability is questionable. Adult learners in collectivist cultures may prioritize group harmony and authoritative guidance over individual autonomy (He, 2013). Secondly, the developmental stage critique challenges the stark distinction between adults and children, arguing that not all

adults possess self-directed capabilities, while some children exhibit strong self-directed tendencies. While Knowles'1980 revision addressed this criticism, his theoretical framework still assumes adults as the primary subject. Thirdly, the narrow concept critique points out that contemporary research tends to equate self-direction with independent learning, deviating from Knowles'original idea that learners can actively integrate external resources. This narrow understanding is particularly inadequate in responding to the reality where technology has become a structured learning resource in the AIGC era (Yin, 2014). These three critiques - cultural bias, developmental oversimplification, and conceptual narrowing - collectively reveal Knowles' theory emerged in a pre-digital educational context. Its understanding of autonomy presupposes that learners possess the ability to engage in learning without intermediaries, without anticipating how technology, as a structural element, reshapes the learner's agency. Most critically, Knowles' framework fails to account for learners with disabilities, for whom technological intermediaries are not optional enhancements but structural prerequisites for participation. This gap necessitates a conceptual reconstruction that distinguishes between types of technological dependence and their relationship to learner autonomy.

3. The Special Context of Adult Learners with Disabilities in the AIGC Era: Identifying Technological Dependence

Having established the theoretical foundations and limitations of Knowles' framework, this study now turns to examining the specific context where these limitations become most apparent: adult learning for persons with disabilities in the AIGC era. The following analysis proceeds in three stages: first, identifying the structural constraints that distinguish disability learning from Knowles' assumed learning context; second, examining how AIGC technology addresses these constraints; third, developing a typological distinction that resolves the tension between technological dependence and learner autonomy.

3.1. Structural Constraints on Adult Learners with Disabilities

Adults with disabilities face structural constraints that distinguish them from typical adult learners, arising from the fundamental barriers posed by physical limitations to participation in learning (Clark, 2006). Physical limitations create fundamental barriers to participation. As noted, visual impairments prevent direct access to text, hearing impairments disrupt auditory engagement, and motor disabilities hinder the operation of standard interfaces. These barriers do not reflect cognitive limitations but rather the absence of accessible learning conditions. Disabled learners may possess sufficient psychological maturity and motivation for learning, but they lose the practical foundation for self-directed learning due to their inability to access learning environments. In the absence of assistive technologies, even if disabled individuals possess the skills emphasized by Knowles, such as ability to diagnose needs, set goals, and evaluate effectiveness, they are unable to translate these skills into actual learning actions. The fundamental challenge facing learners with disabilities differs categorically from typical adult learning challenges: not how to optimize learning strategies, but whether basic participation is possible.

Knowles' framework fails to account for these structural barriers. His concept of self-directed learning rests on an implicit assumption: that learners possess unmediated physical access to learning environments - they can read texts, hear lectures, operate tools, and engage in face-to-face communication. For typical adult learners, this assumption may hold true; however, for learners with disabilities, it constitutes a theoretical blind spot. Knowles' model of the transition from dependence to autonomy describes a psychological shift (from external to internal drive), not a physical transformation (from inability to ability). When learners with disabilities are excluded from learning environments due to physical limitations, the stages of needs diagnosis, goal setting, resource selection, strategy adjustment, and outcome evaluation outlined in Knowles' theory become irrelevant. The theory fails to account for situations where learners must rely on technological intermediaries to participate in learning, and its linear assumption of a transition from dependence to autonomy cannot explain the coexistence of reliance on technology and maintaining autonomy in the context of disability-related learning The advancements in intelligent assistance technology during the AIGC era offer unprecedented possibilities for overcoming these structural constraints, but also present new challenges for evaluating the explanatory power of Knowles' theory.

3.2. The Empowering Mechanism of AIGC Technology for Adult Learners with Disabilities

AI technology provides support for individuals with disabilities to overcome physical barriers and engage in learning environments through various pathways. At the level of accessible participation, screen readers convert text into speech, enabling individuals with visual impairments to access written information. Real-time subtitle systems translate speech into text, allowing individuals with hearing impairments to participate in lectures and discussions. Voice input technology replaces keyboard operation, enabling individuals with physical disabilities to control learning devices. These technologies form the foundational channels for disabled individuals to participate in learning and address the fundamental question of whether they can learn (Guo, 2020). At the level of personalized resource generation, AIGC can create tailored content based on the specific needs, cognitive preferences, and physiological characteristics of learners. For instance, in the case of visually impaired learners learning massage techniques, learners can request AI to generate audio resources that combine theoretical knowledge of meridians with practical examples, and specify a slower speaking pace to suit their individual comprehension rhythm. This enables them to access customized learning materials that are difficult to obtain in traditional learning environments. In terms of immediate feedback, intelligent tutor systems and dialogue agents provide real-time guidance for disabled learners, helping to compensate for their inability to receive face-to-face instruction due to physical limitations, thereby supporting the continuous progression of the learning process. This empowerment mechanism preserves rather than displaces learner agency. While AIGC tools mediate access to learning content, they do not predetermine learning goals, strategies, or evaluation criteria - these remain under learner control. This distinction becomes clear when examining concrete learning scenarios. Knowles emphasizes that self-directed learning is not isolated self-study but rather the integration and utilization of diverse resources under the

guidance of the learner. AIGC tools can be viewed as a new type of learning resource, and the selection, utilization, and integration of this resource by individuals with disabilities represent the contemporary manifestation of self-directed learning in a technological context.

Consider a hypothetical scenario that illustrates this principle: a visually impaired adult learning massage techniques. The learner first reflects on their own needs, identifies knowledge gaps in current basic techniques that cannot meet customer demands for traditional Chinese medicine treatments; then sets goals, plans to master key meridian massage techniques within a specified timeframe; subsequently, actively uses AI-generated audio resources on meridian theory and chooses content formats that incorporate massage practice cases based on professional needs; during the learning process, the learner discusses meridian locations with peers in online communities to adjust their learning strategies; ultimately, they assess their learning outcomes through customer feedback. Throughout this process, technology provides the conditions for participation in learning, while the decision-making authority regarding what to learn, how to learn, and how well one learns remains with the learner. AIGC's personalized generation capabilities particularly reinforce the learner's sense of autonomy: customized resources enable learners to move beyond passive acceptance of generic content, as these resources are no longer predetermined or unadjustable but rather responsive to the learner's needs and tailored to serve their goals.

3.3. Taxonomic Distinctions Between Types of Technological Dependence: Functional Dependence and Alienating Dependence

The dependence of persons with disabilities on AIGC tools is of a nature distinct from general technical dependence, and requires typological differentiation. Functional dependence occurs when persons with disabilities rely on technology to compensate for physical limitations, thereby gaining access to learning opportunities. The essence of this dependence is empowerment: technology enables the learner to act, rather than acting for the learner. In this relationship, the learner acts as the subject and technology as the tool; the learner determines the purpose and method, while technology remains subordinate to the learner's pursuit of meaning. The choices made by visually impaired individuals, such as opting for screen readers instead of magnifying glasses, adjusting audio playback speed to suit their comprehension rhythm, and specifying the format of AI-generated content based on case examples, all demonstrate the learner's dominance over technology. Functional dependence does not undermine the autonomy of the subject; rather, it is a necessary condition for the realization of subject autonomy. Without the functional support of technology, the autonomous consciousness of learners with disabilities cannot be translated into autonomous actions (Guo et al., 2019). From a perspective of value orientation, functional dependence points to the inclusivity of learning, enabling persons with disabilities to participate equally in learning environments that would otherwise be inaccessible due to physical limitations.

In contrast, alienating dependence occurs when technology supplants the learner's autonomous judgment. Here, the learner becomes a mere executor of the technology's logic. In this type of dependence, the relationship between the learner and technology is reversed -

technology transforms from a tool into a dominant force, and the authority over the learning process shifts from the learner to the technological system. Typical manifestations of alienation-based dependence include: algorithm-driven recommendations creating a path dependency, where learners are unable to deviate from predetermined tracks to choose their learning content; the replication of biased generated content, solidifying stereotypes about individuals with disabilities; excessive and intensive feedback provision, which diminishes the learner's space for autonomous judgment; and commercial logic dominating the delivery of resources, forcing learners to accept irrelevant content. For instance, if an AI tool used by a visually impaired learner forcibly pushes commercial advertisements instead of requested instructional content, the relationship transitions from functional to alienating dependence. The learner loses control over both the content and the process (Liu, 2024). The typological distinction between functional dependence and alienating dependence holds dual theoretical significance: on one hand, it addresses concerns about technological alienation, demonstrating that the technological dependence of persons with disabilities differs fundamentally from technological alienation in general terms; on the other hand, it provides conceptual tools for subsequent propositional deduction, clarifying the explanatory efficacy of Knowles' theory within the context of AIGC, with functional dependence serving as the applicable boundary.

This functional-alienating distinction intersects with developmental stages in self-directed learning. Recall that Grow proposed a four-stage model of learner development: dependent, interested, participatory, and autonomous. For learners with disabilities, technological relationships vary across these stages. Learners in earlier developmental stages (dependent, interested) may require structured technological support to maintain functional dependence. Learners in advanced stages (participatory, autonomous) can independently evaluate and deploy AIGC tools to serve their learning goals. Crucially, at all developmental stages, technological dependence remains functional rather than alienating when learners retain authority over learning objectives, resource evaluation, and outcome assessment. The functional or alienating orientation of technological dependence thus depends on both the design of AIGC tools and the learner's developmental stage.

4. Theoretical Exposition and Conceptual Reconfiguration of the Explanatory Power of Knowles' Theory for the Learning of Adults with Disabilities

Having established the distinction between functional and alienating dependence, this section examines the explanatory power of Knowles' theory in this new context of technology-mediated disability learning. Five interrelated propositions reconstruct the theory's applicability while preserving its core logic.

The five propositions presented in this section are not independent claims but constitute a logically progressive framework. The foundational proposition establishes the continued validity of Knowles' core psychological assumptions regarding adult learners. Building on this premise, the revised proposition extends the original theory by redefining the pathway through which self-directed learning is realized under technological mediation.

The dialectical proposition addresses the tension that emerges from this extension by demonstrating how functional technological dependence and learner autonomy can coexist rather than conflict. The boundary proposition then delineates the conditions under which this coexistence holds, specifying the point at which technological dependence becomes alienating and undermines autonomy. Finally, the conceptual reconstruction proposition integrates these preceding arguments into a revised definition of self-directed learning for adults with disabilities in the AIGC era. Together, these propositions form a coherent theoretical progression from validation, extension, and resolution to reconstruction.

These propositions demonstrate how the functional-alienating distinction resolves the theoretical tension between dependence and autonomy. When technological dependence remains functional - serving learner goals rather than supplanting learner judgment - Knowles' framework retains explanatory power. The boundary between functional and alienating dependence thus determines the theory's applicability.

4.1. Foundational Proposition: Validating the Original Theory's Core Logic

As established in Section II, Knowles' theory rests on five assumptions about adult learners, particularly psychological maturity and experiential accumulation as prerequisites for self-directed capacity. Adults develop the ability to identify their own learning needs, plan learning strategies, and evaluate outcomes through accumulated life experiences addressing career challenges and personal issues. This psychological maturity, rather than physical ability, provides the internal foundation for self-directed learning. This section demonstrates that these prerequisites hold regardless of physical ability.

As adult learners, the psychological maturity and experience of individuals with disabilities do not change due to their physical limitations. Although physical limitations may prevent conventional participation, they do not diminish the adult capacity to reflect on their learning needs, plan paths, and evaluate learning effectiveness. As demonstrated in the massage learning scenario discussed previously, visually impaired learners retain the capacity to identify knowledge gaps, set professional goals, and evaluate outcomes through client feedback - capacities rooted in metacognitive development rather than physical ability (Guo & Gao, 2025). AIGC tools can provide resource support and process assistance, but they cannot replace the learner's reflection on their own needs, the setting of learning goals, and the evaluation of learning outcomes. These aspects rely on the learner's meta-cognitive abilities, which are traits that belong to the psychological rather than the physical realm. Therefore, the fundamental logic of the Knowles theory, which posits that the learner's agency plays a dominant role, remains valid for adult learning by persons with disabilities: While these individuals may require technical support, they still need to possess the psychological maturity to identify their needs, plan their path, as an intrinsic basis for self-directed learning. Regarding the concern that not all adults possess self-directed abilities, Grow's stage model offers an answer: self-direction is a developable ability rather than a static trait, and learners can transition from dependence to autonomy with appropriate support. For persons with disabilities, AIGC tools, when designed properly, can serve as scaffolding to facilitate their transition from dependence to autonomy.

4.2. Revised Proposition: From Unmediated Autonomy to Technologically Mediated Self-Direction

While the core psychological prerequisites for self-directed learning remain constant regardless of physical ability, the pathway to implementing self-directed learning must be revised to account for technological mediation. Knowles' original theory implicitly assumes learners possess the ability to engage in learning without intermediaries. However, physical limitations undermine this assumption: visually impaired learners may not read standard text, hearing-impaired learners may not access auditory content, and motor-impaired learners may struggle with standard equipment. For these individuals, AIGC technology serves as an essential intermediary to overcome physical boundaries, utilizing tools such as screen readers, real-time captioning, and voice input systems. This technology does not rely on passive dependence but rather on active functional choices - where learners with disabilities use technology to compensate for their physical limitations and gain access to learning opportunities - a prerequisite for learner agency. AIGC interventions do not negate Knowles' original proposition; rather, they reconstruct the pathway to realizing autonomy through the functional premise of technological dependence: transitioning from unmediated autonomy to autonomy under technological mediation.

Recall the massage learning scenario: technology enables access (audio resources), while the learner controls the purpose (skill development), method (playback speed), and evaluation (client feedback). Throughout this process, technology enables learners to learn, while the learners themselves decide what to learn, how to learn, and how well they learn. To illustrate this, we can refer to Garrison's three-dimensional model: the autonomous entity's behavior is manifested through the coordinated operation of self-management, self-monitoring, and motivation-driven decision-making. The learner's selection and control of technological tools belong to self-management, their meta-cognitive reflection of the learning process belongs to self-monitoring, and their internal grasp of the learning significance belongs to motivation-driven decision-making (Wu & Yang, 2018). Although persons with disabilities rely on technology to access learning opportunities, they remain in control of the fundamental decisions regarding what to learn, how to learn, and how well to learn. Thus, the logic of shifting pathways while maintaining learner control remains consistent.

4.3. Dialectical Proposition: The Synergistic Relationship Between Functional Technological Dependence and Learner Autonomy

The academic community's concerns about technological dependence stem largely from theoretical assumptions about the dehumanization of technology - where technology transforms from a tool into a dominant force, and learners become subservient to it. However, in the context of adult learning for persons with disabilities, the essence of technological dependence is functional empowerment: the role of technology is to compensate for physical limitations and enable learners to participate in learning, rather than to replace their own choices. Functional empowerment does not oppose learner agency; rather, it creates a synergy between tools and values. Technology serves as the means, while learner agency remains the ultimate purpose.

Take the learning of sign language translation skills by individuals with hearing impairments as an example: the learner uses an AI subtitle tool to watch sign language translation videos, which represents technological dependence; the choice to opt for sign language translation over text subtitles, as sign language better aligns with their communication habits, reflects learner agency; adjusting font size and color represents self-management; and applying sign language skills to enhance vocational abilities represents value-driven learning (Wang & Wang, 2025). Throughout the entire process, AI subtitles serve as a tool. The needs and goals of the learners are the primary drivers of value – technology serves the value, not the other way around. Functional dependence is a means, while the autonomy of the subject is the ultimate goal. These two elements together constitute the complete logic of self-directed learning for persons with disabilities in the era of AIGC. The personalized generation capabilities of AIGC technology can further enhance rather than diminish the autonomy and agency of learners with disabilities. Knowles has pointed out that the key to self-directed learning lies in the ability of learners to find resources that meet their individual needs. In traditional learning environments, individuals with disabilities often struggle to access customized resources. For instance, visually impaired individuals may find it difficult to locate audio versions of massage instructional materials with case studies. The personalized generation capabilities of AIGC can address this challenge by generating customized resources tailored to the needs, learning styles, and physical characteristics of individual learner (Mou, 2017). Students with visual impairments can request audio generated by AI with a slower speaking pace and features that simulate a massage on the bladder meridian to alleviate back pain. This enables them to access learning materials that are perfectly tailored to their individual needs. Customized resources empower disabled learners to take greater control over the content of their learning. Instead of being generic and unsuitable, these resources are personalized to meet their specific needs. This mechanism not only enhances the learning outcomes but also reinforces the learner's sense of agency: learning is about fulfilling one's own needs, and technology serves as a tool to facilitate this fulfillment. Drawing on the concept of deep self-directed learning, when disabled learners are able to critically integrate new knowledge into their existing cognitive structures and apply it in new problem-solving contexts, their self-directed learning transitions from superficial to deep levels. The personalized support provided by technology creates conditions for deep self-directed learning rather than acting as a hindrance.

4.4. Boundary Proposition: Conditions Limiting the Explanatory Power of the Theory

The validity of the above proposition is contingent upon the context in which technology serves as a facilitator of learner needs. In this scenario, technology acts as a functional intermediary, and learners dictate the purposes and methods for using technology. If technology becomes an agent of alienation, the proposition loses its validity. Specific instances of alienation include: algorithmic recommendations creating path dependence, where learners are unable to deviate from predetermined tracks to choose their learning content; generated content exhibiting replication bias, solidifying stereotypes about individuals with disabilities; data collection infringing on privacy and commercializing the use of learners' learning behaviors; feedback provision becoming overly dense, diminishing learners' space for autonomous judgment;

commercial logic dominating resource dissemination, forcing learners to accept unrelated content. For example, if an AI tool forces commercial advertisements instead of requested content, dependence transitions from functional to alienating. In this state, the learner loses control over the process, rendering learner agency impossible (Fan et al., 2025).

Practically, this boundary proposition implies that the design of AIGC educational tools must prioritize learner goals as the fundamental principle. The algorithmic logic of technology should be guided by the needs of the learners rather than by considerations of traffic or commercial interests; resource delivery should respond to explicit requests from learners rather than making forced recommendations based on predetermined preferences; feedback mechanisms should support learners' autonomous judgment rather than replacing their independent thinking with excessive and immediate feedback. Only when technology serves learner needs can the synergy between functional dependence and learner autonomy be achieved, and the explanatory power Knowles' theory in the era of AIGC can be upheld. This boundary setting also addresses concerns about technological alienation: the dependence on technology is not inherently problematic; the issue lies in whether technology serves the needs of learners. There is a fundamental difference between the technological dependence of persons with disabilities and the general phenomenon of technological alienation; the former serves as a support for autonomy, while the latter erodes autonomy.

4.5. Conceptual Reconstruction: Defining Self-Directed Learning Under Technological Mediation

Based on this logical deduction, we propose a revised definition of self-directed learning for adults with disabilities: Under the mediation of AIGC and other assistive technologies, adults with disabilities take the lead in diagnosing their learning needs, setting learning goals, selecting and integrating technical resources, monitoring and adapting learning strategies, and reflecting on learning outcomes. This process ultimately leads to self-development and social participation. The revised definition encompasses three modifications: (1) Path modification (shifting from unmediated to technology-mediated learning); (2) Method modification (transitioning from solitary effort to active resource integration); and (3) Goal modification (shifting from mere knowledge acquisition to broader self-development and social participation) (Liu et al., 2024).

This concept reconstruction has a dual relationship of inheritance and development with Knowles' original theory. On the inheritance level, the reconstructed concept retains the fundamental logic of Knowles' theory, which emphasizes the learner's centrality in terms of the meaning, path, and effects of learning. The setups for needs diagnosis, goal setting, resource selection, strategy regulation, and effect evaluation continue to use Knowles' process model framework. On the development level, the reconstructed concept breaks away from the historical limitation of Knowles' theory without a technological context, incorporating technological mediation into the analytical framework of self-directed learning. It revises the understanding of autonomy, moving from unmediated autonomy to autonomy under technological mediation. It addresses the academic debate on whether technology dependence erodes autonomy by demonstrating that technological dependence of individuals with disabilities can coexist with

their autonomy. Theoretically, this reconstruction is neither a negation nor a simple application of Knowles' theory. Rather, it represents a critical inheritance and creative development of Knowles' theory within the technological context of the AIGC era, allowing classic theories to regain their explanatory power in new historical contexts.

In addition, the reconstruction of self-directed learning also requires cultural contextualization. Knowles' conception of autonomy reflects an individualistic orientation that emphasizes independence from external support. In the Chinese context, however, autonomy is more commonly understood as the capacity to act effectively within relational and institutional support structures.

Adult learners with disabilities in China typically engage in learning within family, community, and public service systems. Self-directed learning therefore manifests not as the withdrawal of support, but as learners' capacity to define goals and regulate learning within mediated arrangements. Under such conditions, reliance on technology aligns with culturally situated forms of agency rather than contradicting them.

5. Theoretical Integration & Practical Implications

Having reconstructed Knowles' theory for technology-mediated disability education contexts, this section integrates the theoretical propositions into a unified operational framework, articulates practical implications for AIGC tool design and educational practice.

5.1. Mechanisms of Operation of Self-Directed Learning Under Technology Intermediation

The proposed Three-Tier Analytical Framework clarifies the synergy between technological dependence and learner autonomy. It consists of the Functional Tier (access), the Mechanism Tier (control), and the Value Tier (meaning). At the functional layer, AI technology compensates for physiological limitations through accessibility features (screen readers, real-time captions, voice input), addressing the prerequisite question of learning participation rights. At the mechanism layer, learners exercise autonomous control over technology use through self-management (selecting and regulating technical tools), self-monitoring (metacognitive reflection on learning processes), and motivation-driven decision-making (determining learning purpose and significance). At the value layer, technology-mediated learning enables persons with disabilities to achieve self-development and social participation, returning self-directed learning to its essential purpose of human flourishing rather than mere knowledge acquisition. These three layers operate recursively: functional accessibility enables mechanism-layer autonomy, autonomous regulation realizes value-layer goals, and value orientation provides meaning to functional and mechanism processes.

5.2. Synergy between Technology Empowerment and Subject Autonomy: The Implementation Path of Self-directed Learning for the Disabled in the AIGC Era

Psychological maturity and experience accumulation in adults are prerequisites for self-directed learning, independent of physical health. Although learners with disabilities rely on technology for learning due to their physical limitations, they still need metacognitive ability to

identify needs, plan pathways, and evaluate effectiveness as an intrinsic basis for self-directed learning. Knowles' theory requires a pathway correction: shifting from the assumption of unmediated autonomy to a recognition of autonomy under technological mediation. AIGC tools become a structural element of learning for people with disabilities, but leadership remains with learners - the technology helps people with disability learn, and they decide what to learn, how to learn and how to learn. The dependence of disabled people on AIGC tools belongs to functional dependence. In essence, it is an enabling mechanism to break through the physiological boundary, and forming a cooperative rather than antagonistic relationship. The tension between empowerment and alienation resolves when we distinguish functional dependence (autonomous support) from alienating dependence (autonomy dissolution). When technology serves the needs of learners, dependence is autonomous support. When technology becomes the dominant player in the learning process, dependency constitutes the dissolution of autonomy. This distinction provides a conceptual tool for judging the reasonable boundary of technical intervention, and also provides a theoretical basis for the technical design and practice of adult education for the disabled in the age of AIGC.

Regarding technical design, accessible AIGC tools must adhere to learner-centered principles across three levels:

(1) Accessibility Interaction: Adaptable modules must address specific physiological characteristics. For visually impaired learners, tools should optimize speech synthesis quality, support rapid audio positioning (e.g., chapter marking), and integrate tactile feedback systems. For hearing-impaired learners, tools require improved real-time caption accuracy, customized technical vocabulary expansion, and two-way sign language translation capabilities. For physically impaired learners, systems should enhance voice command recognition and support alternative inputs like eye-tracking and head-movement sensors.

(2) Personalized Resource Generation: Learners must be supported in tailoring content formats - such as requesting audio with practical examples (for visual impairment) or visually illustrated explanations (for hearing impairment). Furthermore, learners should control presentation parameters (e.g., playback speed, font size) and organizational structure (e.g., case-oriented vs. systematic).

(3) Algorithmic Logic: Resource delivery must respond to explicit learner requests rather than forced recommendations based on preset preferences. Algorithms should be oriented toward learning goals rather than commercial interests, strictly avoiding path dependency, bias replication, and privacy infringement (Wei et al., 2025).

Regarding educational practice, programs must cultivate the learner's ability to maintain autonomy while using technical intermediaries. Interventions should align with the stages of self-directed learning:

(1) Needs Diagnosis: Educators should help learners distinguish between immediate and long-term needs, converting vague intent into clear learning problems. Tools like career development counseling and peer experience sharing can help identify intrinsic drivers.

(2) Goal SettingLearners should be guided to translate broad directions into assessable, phased goals. Learning contracts and progress visualization tools help establish logical links between goals and actions.

(3) Strategic Regulation: Emphasis should be placed on metacognitive monitoring - such as adjusting learning rhythms or replacing technical tools based on adaptability. Peer evaluation mechanisms can further strengthen reflection awareness.

(4) Effectiveness Evaluation: Evaluation criteria must be diverse, covering knowledge mastery, skill upgrading, and practical application. Educators should facilitate objective indicators through practical task testing and professional qualification certification.

(5) Community Building: Online and offline platforms should be established to promote experience sharing and remedy the lack of social presence in AIGC tools, encouraging learners to deepen their self-directed capacity through collaboration (Zhuang & Goggin, 2024). The common orientation of these practice pathways is to ensure that learners with disabilities continue to take the lead in fundamental decisions about what, how and how to learn under technical intermediation, thereby achieving the integration of inclusive learning and self-actualization, returning self-directed learning to its essential purpose within adult education: human flourishing and development.

Within the Chinese policy framework, adult education for persons with disabilities is explicitly oriented toward educational equity and social participation. Learning is framed not only as individual development but as a means of reducing structural exclusion and enabling participation in social and vocational life.

In this context, technological mediation assumes normative significance. It functions as an institutional mechanism that secures learning access and supports participation under conditions of structural disadvantage. Accordingly, the reconstructed model of self-directed learning evaluates autonomy not by the absence of dependence, but by learners' capacity to act meaningfully in society through mediated learning.

6. Conclusion & Future Direction

This study makes three theoretical contributions to adult education scholarship and disability studies. First, it extends Knowles' self-directed learning theory beyond its original pre-digital context by demonstrating that psychological prerequisites for self-directed learning remain valid under technological mediation, while implementation pathways require revision from unmediated to technology-mediated autonomy. Second, it resolves longstanding scholarly debates about whether technological dependence erodes learner autonomy by introducing a typological distinction between functional and alienating dependence, showing these represent qualitatively different relationships between learners and technology. Third, it provides a three-tier analytical framework - functional, mechanism, and value - that clarifies how AIGC tools can enable rather than undermine self-directed learning for persons with disabilities when designed to serve learner goals.

This study has several limitations that should be acknowledged. First, as a conceptual reconstruction, the analysis relies on theoretical deduction rather than empirical validation. While this approach allows for clarifying conceptual boundaries and theoretical logic, the proposed distinctions - particularly between functional and alienating technological dependence - require empirical examination in diverse learning contexts.

Second, although the typology of technological dependence provides analytical clarity, its operationalization remains underdeveloped. The criteria for identifying functional versus alienating dependence need to be translated into observable indicators to support future empirical research. Addressing these limitations will enable subsequent studies to test, refine, and extend the reconstructed framework.

Future research should investigate how the functional-alienating distinction manifests across different disability types, learning contexts, and cultural settings. Longitudinal studies could examine how learners with disabilities progress through Grow's developmental stages under technological mediation, and whether AIGC scaffolding effectively facilitates transitions toward greater autonomy. Additionally, the framework developed here focuses on individual learners; future work should explore how technology-mediated self-directed learning operates in collaborative learning communities for persons with disabilities. Finally, as AIGC technologies continue evolving, ongoing theoretical work must examine emerging forms of technological mediation and their implications for learner autonomy.

The integration of AIGC technology into adult education for persons with disabilities represents both opportunity and challenge. By distinguishing functional from alienating dependence, this study provides conceptual tools for ensuring that technological advancement serves inclusive education rather than creating new barriers to autonomy. The revised understanding of self-directed learning under technological mediation allows Knowles' foundational theory to regain explanatory power in contemporary contexts while addressing the specific structural constraints facing learners with disabilities.

Data Availability Statement:

Not applicable.

Conflict of Interest:

The authors declare no conflict of interest.

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