



Cognitive Load and Digital Habitus: A Micro-Analysis of the Usage Gap in Rural Adaptive Learning Platforms

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Abstract. The “Artificial Intelligence Empowering Education” of the Ministry of Education clearly points out that the development of “Intelligent Learning Partners” and the promotion of “Large-scale Individualized Instruction” are critical engines for modernizing the education system. Under this policy framework, adaptive learning platforms (ALPs) are regarded as vital for providing high-quality, balanced compulsory education and for bridging disparities between urban and rural areas. However, the deployment of these platforms in rural schools has raised challenges related to the “usage gap”. Specifically, this study identifies three micro-level barriers. The environmental instability causes “technostress”, which increases students’ additional cognitive load. The complex interface causes “cognitive overload” and “split-attention” in rural teachers who lack support. A deficit in academic digital habitus leads to “habitus displacement”, that is, learning devices are used for recreational activities that require little cognitive effort. Consequently, the implementation logic should shift from the “arithmetic equality” of hardware distribution to a “priority view” of cognitive support for vulnerable groups. This paper advocates the use of inclusive interface design to reduce cognitive barriers and the construction of digital learning communities to reshape the digital habits of rural learners, ensuring that technology empowers rather than overwhelms them.

Keywords: adaptive learning platforms (ALPs); cognitive load; digital habitus

1 Introduction

In recent years, the integration of artificial intelligence into education has become an inevitable requirement of global education modernization. In China, this trend has been institutionalized through the “Artificial Intelligence Empowering Education Action”[1]. The strategic action clearly positioned adaptive learning platforms (ALPs), commonly referred to as “Intelligent Learning Partners”, as the core infrastructure to achieve “Large-scale Individualized Instruction”. By using data-driven algorithms to promote personalized learning paths, ALPs are widely praised as a “transformative solution” to bridge the education gap. The current policy assumption is that by deploying these digital tools to rural schools where educational resources are scarce, the government can effectively break through the constraints of time and space, so that

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rural students can obtain the same high-quality educational resources as urban students, and realize the high-quality and balanced development of compulsory education.

However, the empirical reality reveals the disturbing gap between this policy ideal and the actual implementation results. Although the large amount of government investment has significantly narrowed the first-level (hardware access) of the digital divide, the more hidden second-level (usage and effects) remains widespread. The current implementation strategy often follows a logic of “arithmetic equality”, that is, a technical solutionism, which believes that fairness can be achieved as long as the same tablet and software account are distributed to each student, regardless of their background. This approach ignores deep-seated structural differences. As a result, in the rural environment, technology not only fails to act as a bridge, but often leads to “rejection reaction”, leading to waste of resources and alienation between teachers and students.

Therefore, merely asking “how to equip schools with technology” is no longer enough; we must ask “how technology interacts with the cognitive and behavioral patterns of rural users”. Although previous studies have explored this issue at the macro-structural level, there is still little research on the mechanisms at the micro level. This paper aims to construct a conceptual framework to examine the “usage gap” in the implementation of smart education from the perspective of digital habitus and cognitive load theory (CLT). By comparing the deployment of ALPs in urban and rural environments, this study analyzed three key dimensions of this gap: the additional cognitive load imposed by “technostress”; the “split-attention” of the complex interface on rural teachers; and the displacement of students’ habitus due to a lack of scholarly digital capital. Finally, based on the philosophical distinction between “equality” and “priority”, this paper proposes a paradigm shift for future policies: from a mechanical equal distribution of resources to a “priority view” that emphasizes capacity-building and differentiated support for the disadvantaged.

2 The “Usage Gap” in Rural Smart Education: A Micro-Perspective of Cognition and Habitus

Under the guidance of the national strategy for education digitalization, China has made historic achievements in bridging the “first-level digital divide” (access). In 2021, the Internet access rate in primary and secondary schools reached 100%, an increase of 75 percentage points over 2012. More than three-quarters of schools have achieved wireless network coverage, with 99.5% of multimedia classrooms (more than 4 million in total), and more than 28 million teacher-student terminals[2]. This has laid a solid material foundation for the vision of “Large-scale Individualized Instruction”. However, as the focus of education reform has shifted from “scale expansion” to “quality improvement”, empirical observation shows that when the same ALPs are introduced into rural areas, it cannot automatically transform into the expected educational benefits. Instead, a stubborn usage gap has emerged.

Unlike previous macro-level studies that attribute this gap primarily to resource allocation, this section examines it from the perspectives of micro psychology and soci-

ology. This paper argues that the core challenge faced by rural smart education is not simply the lack of hardware, but the mismatch between the technological environment and the user's cognitive architecture. This mismatch is particularly significant in the three dimensions of environmental pressure, teachers' cognitive load and students' digital habitus.

2.1 The Environmental Dimension: Infrastructure Instability as a Source of “Technostress”

At the micro level, the defect of infrastructure is not only the instability of connection, but also a psychological trigger for “technostress”. According to the P-T (person-technology) fit model[3], this stress arises from a structural mismatch between the unstable supply of the technological environment and individuals' limited cognitive resources. Although rural schools have been equipped with hardware, the vulnerability of their “availability environment” results in very low user-perceived system “reliability”. It is worth mentioning that the actual system failure is not a necessary condition for generating stress; just “fear of breakdowns” forces users to allocate more cognitive resources for “preventive monitoring”, which is a defensive psychological behavior. Users are forced to constantly distract themselves to check the network signal status to prevent possible network disconnection. This extra attention requirement greatly exacerbates the perceived “work overload”. For rural students, this creates a high-cost “dual task” dilemma: they need to manage academic content (intrinsic load) and deal with the interference caused by the network buffer. This interference caused by technology has brought high “resumption lag” costs, forcing the brain to constantly re-enter the task. In a 45-minute classroom, this persistent and unreliable threat and the small interference accumulated from it will quickly deplete the working memory used to build the knowledge framework. Finally, this cognitive exhaustion makes the tools that should help learning become a source of frustration.

2.2 The Teacher Dimension: “Split-attention Effect” and Cognitive Overload

The effective implementation of smart education largely depends on teacher agency. From the perspective of cognitive load theory (CLT), rural teachers' alienation from technology is not a subjective rejection but an objective result of “cognitive overload” due to a lack of support structures.

Specifically, rural schools usually have structural deficiencies in technical support. According to Zhang and Liu[4], there is a severe shortage of full-time IT support personnel in rural areas, and about 20% to 30% of the technical maintenance work is completed part-time by teachers in other disciplines. Therefore, rural teachers are compelled to assume multiple, conflicting roles simultaneously: educators, device technicians, and network administrators. This overlap of roles creates a severe “split-attention effect”[5].

In this case, in the process of AI-assisted instruction, rural teachers often need to interpret complex real-time data from the dashboard of ALPs (such as identifying

students with learning difficulties), and also solve technical problems (such as repairing the screen stuck by students). The interface of ALP is usually designed based on the concept of “rich data”, presenting dense visual content, which requires a lot of effort to understand. For teachers without full-time assistants, the cognitive load of integrating various information sources, including digital dashboard, physical classroom environment and equipment technical status, is far beyond their processing ability. This cognitive overload forces teachers to give priority to solving immediate technical problems (extraneous load) at the expense of in-depth teaching interaction (germane load). Due to these structural factors, rural teachers’ professional agency in the use of ALPs has been significantly reduced. In fact, they have been reduced from “instructional designers” to “system operators”. Finally, this loss of agency led to a profound lack of confidence in the effectiveness of AI-assisted learning.

2.3 The Student Dimension: Cognitive Thresholds and “Habitus Displacement”

The cognitive and sociological characteristics of rural students seriously restrict the realization of the ultimate goal of the autonomous learning plan, that is, the cultivation of autonomous learning ability.

In terms of cognitive processing, the complex interface design of ALPs constitutes a high “cognitive threshold”. An empirical study [6] shows that rural students scored significantly lower than urban students in the “foundational dimension” of digital literacy, especially in “access and use” and “understanding and evaluation”. This structural deficiency in the application and understanding of basic functions confirms that rural students lack the internalized digital mode owned by urban students, which makes it difficult for them to interpret basic software logic, such as multi-layer navigation menus or complex interaction rules.

In the dimension of behavior pattern, the lack of digital habitus leads to a profound phenomenon of “habitus displacement”. In the absence of effective supervision, rural students often use educational tablets for non-academic entertainment activities, such as playing games or watching short videos[7]. Based on Bourdieu’s concept of “embodied cultural capital”[8], this trend reveals deep-seated differentiation: unlike urban students’ acquisition of “academic digital habitus” with family support, rural students are often subject to the existing “recreational habitus” formed by the use of smartphones. Due to the lack of an inherent tendency to regard the screen as a workspace, educational equipment has been redefined as a “toy” in culture. Therefore, the technological tools originally designed to empower have been functionally alienated; Instead of improving learning efficiency, they have become the main cause of cognitive bias and distraction.

Finally, the dual barriers of cognitive threshold and habitual displacement lead to the functional alienation of the adult learning plan in the rural context. It not only failed to bridge the gap but also evolved into an implicit screening mechanism, which exacerbated the educational stratification by ignoring the user-specific cultural capital differences.

3 From “Arithmetic Equality” to “Cognitive Support”: Strategies for Reconstructing Rural Smart Education

The above analysis illustrates that the “usage gap” is fundamentally a crisis caused by the mismatch between cognitive compatibility and digital habitus. Therefore, the solution is not to simply increase the number of devices (arithmetic equality), but to provide differentiated “priority support” according to the cognitive characteristics of rural users. We propose three key strategies to reconstruct the implementation logic: cognitive-friendly design, AI-empowered teachers and the construction of digital communities.

3.1 Reducing Extraneous Load: The Necessity of Inclusive Interface Design

In order to solve the problems of “technostress” and “cognitive overload” mentioned in Section 2, ALPs developers should shift their design concept from “feature-rich” to “cognitive minimalism” and “environmental inclusiveness”.

To alleviate environmental anxiety, the system should have a powerful offline function. In view of the instability of the rural network, the platform should support the “store and forward” mechanism, so that students can download the learning module when there is a network and continue learning seamlessly offline. This technical adjustment not only ensures the continuity of learning but also reduces the psychological fear caused by network interruption. Therefore, students no longer need to be vigilant due to the uncertainty of the environment, and attention resources can be refocused on the learning content itself. In addition, the platform should adapt to the low-bandwidth environment to ensure that key teaching videos can be loaded smoothly even under the limited data package.

In the aspect of interaction design, the interface should give priority to fault tolerance and cognitive minimalism. For students with limited digital literacy, visual clutter is the main reason for the surge of additional cognitive load. Therefore, the platform should resolutely remove distracting decorative elements and establish a clear functional hierarchy. At the same time, for key technical pain points such as inaccurate handwriting recognition, the algorithm must be optimized to adapt to the uneven quality of rural hardware input, and provide a guiding feedback mechanism, rather than a simple error report. The system uses intuitive interaction design to eliminate the complexity of navigation levels, so as to effectively reduce the cognitive cost of use. This ensures that students’ valuable attention can focus on the construction of core knowledge rather than being occupied with mechanical operations at the tool level.

3.2 Institutional Support and Data Pedagogy: Building a Human-Centered Educational Ecosystem

The focus of intervention should shift from simple equipment deployment to the systemic restoration of teacher professional agency.

In order to achieve “cognitive offloading”, institutionalized technical support systems should be established. The school should employ full-time IT maintenance personnel to separate teachers from burdensome equipment operations and network troubleshooting (extraneous cognitive load), so as to eliminate the “split-attention effect” caused by conflict. This significant adjustment liberates the cognitive resources previously consumed by technical demands, allowing teachers to revert to their core role as educators.

In the dimension of professional development, the core of empowerment is to establish the “interpretive authority” and “veto power” of teachers in human-AI cooperation. The teacher training should not be limited to operational skills, but should turn to the cultivation of “data pedagogy”, that is , to give teachers the ability to critically interpret ALPs data. The AI-system should be repositioned as an assistant providing advice rather than an authority giving instructions. By ensuring that teachers have the final decision-making power to override the proposed algorithm, we need to rebuild a people-centered education ecosystem. In this ecosystem, technology is responsible for handling the standardized knowledge transmission, while teachers utilize their energy to focus on those areas that cannot be replaced by algorithms, including emotional support, value guidance, and deep engagement with complex learning contexts.

3.3 Reshaping “Digital Habitus” through Community Building and Preparatory Training

Finally, addressing the “usage gap” requires a sociological shift to transform rural students’ fundamental perception of digital technology. To transform the deep-rooted “recreational habitus” (regarding electronic devices as toys) into “academic digital habitus”, schools should actively cultivate a standardized digital learning culture.

It is an effective strategy to build a “virtual learning community” in the ALPs ecosystem. Cultivating a strong sense of belonging is essential to improve students’ participation. By creating a secure and regulated online space, students can share learning progress and cooperate to solve problems. The system can use peer influence to strengthen positive learning behavior. In this collective environment, the habit of using devices to explore will be reshaped by society, gradually replacing the previous habit of passive entertainment consumption.

In addition, cultivating digital literacy should not be resigned to fate, but need active intervention. Before technology deployment, it is essential to conduct preparatory training for students. Schools should implement special guidance courses, focusing on digital literacy and autonomous learning, and clearly teach students to distinguish between “instrumental use” and “recreational use”. This preparatory stage plays a vital role of “cognitive guidance”, which establishes a behavioral framework before technical immersion to prevent initial technological novelty from evolving into the dissipation of attention.

4 Conclusion

As revealed by the analysis presented in this study, the digital divide in the AI era has undergone a fundamental change, that is, from a visible “access gap” to an invisible “usage gap” rooted in cognitive and sociological disparities. Consequently, to achieve real education equity, we should promote the transformation of the paradigm from simple “arithmetic equality” to differentiated “cognitive support”. In order to implement effective intervention, a trinity reconstruction is necessary: implementing cognitively minimalist designs to lower entry barriers, restoring teacher agency through “data pedagogy” and veto power, and actively reshaping students’ digital habitus from recreational to instrumental use. Fundamentally, technology is not an independent scheme that can take effect automatically without being separated from the social context. Its effectiveness must be rooted in the comprehensive social and pedagogical support system. By establishing the centrality of human agency within the technical system, AI-powered education can effectively promote social mobility rather than aggravating existing stratification, so as to guide rural students from passive recipients to empowerment subjects who can master technology to achieve their own development.

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