JOURNAL OF CURRENT SOCIAL ISSUES STUDIES Volume 2 Issue 5 , 2025, 306- 315
ISSN (P): 3078-5316 | ISSN (E): 3078-5324 Doi:10.71113/JCSIS.v2i5.291

A Review of Adolescents' Digital Self-Efficacy: Conceptualization, Measurement, Impacts, Influencing Factors, and Future Directions

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Abstract

With the deep penetration of digital technology in life and education, the cultivation of digital literacy among adolescents has become a focus. As a key component of digital literacy, digital self-efficacy profoundly affects adolescents' use of digital systems and the development of digital competence. In this paper, we systematically review the current status of research on adolescents' digital self-efficacy at home and abroad, elaborating on the evolution of its concept, the development of measurement tools, and analyzing its role in the use of digital systems and learning, as well as the influencing factors at the environmental and individual levels. At the same time, we point out the shortcomings of the current research in terms of conceptual connotation and structure, local characteristics, systematicity of influencing factors, formation and mechanism of action, and interventions, etc., and provide directions for the subsequent in-depth research, aiming to promote the development of the research on adolescents' digital self-efficacy, and help to improve adolescents' digital literacy.

Keywords : Adolescents; digital self-efficacy; digital literacy; research review

Suggested citation : Tan, Q., Wu, W., & An, S. (2025). A Review of Adolescents' Digital Self-Efficacy: Conceptualization, Measurement, Impacts, Influencing Factors, and Future Directions. *Journal of Current Social Issues Studies*, 2(5), 306–315. https://doi.org/10.71113/JCSIS.v2i5.291

Introduction

General Secretary Xi Jinping pointed out in the thirty-fourth collective study of the Political Bureau of the Central Committee that "it is necessary to improve the digital literacy and skills of all people and society as a whole, and to strengthen the social foundation for the development of China's digital economy". Along with the rapid updating of digital technology, digital products are more convenient to operate and the tasks that can be accomplished are becoming more and more complex (Vrontis et al., 2021; Jiang, 2021), and the use of digital products is increasingly becoming an important part of daily life (Parker & Grote, 2020; Jiang et al., 2023). This also makes it even more important to be digitally competent in order to adapt to modern life (Larson & DeChurch, 2020; van Kessel et al., 2022; Wang et al., 2022). Especially in the field of education, learning and living effectively with the help of digital products has become an important skill for contemporary primary and secondary school students (Zhang et al., 2021).

Enhancing the digital literacy of adolescents has been a critical concern closely monitored by the Chinese government. As early as 2016, the Opinions on Strengthening Cybersecurity Discipline Development and Talent Cultivation jointly issued by six departments including the Office of the Central Leading Group for Cybersecurity and Informatization emphasized that "cybersecurity education should start with children, and adolescent digital literacy education must be prioritized" (Office of the Central Leading Group for Cybersecurity and Informatization et al., 2016). In subsequent years, policy documents released by the Central Committee of the Communist Party of China, the State Council, the Ministry of Education, and other departments repeatedly underscored the importance of digital literacy (e.g., State Council Information Office of China, 2017; General Office of the Central Committee of the Communist Party of China and General Office of the State Council, 2017; National Development and Reform Commission of China, 2018; Central Committee of the Communist Party of China and State Council, 2019; General Office of the Ministry of Education and General Office of the Ministry of Finance, 2020; Cyberspace Administration of China, 2021, 2022).

Similarly in 2016, the Organisation for Economic Co-operation and Development (OECD) identified the knowledge and skills related to operating digital devices (e.g., computers, smartphones, tablets), applications, and digital environments as essential 21st-century competencies (OECD, 2016). The European Union further refined this digital competence framework into five dimensions: information and data literacy, digital communication and collaboration, digital content creation, digital security, and digital problem-solving (Carretero et al., 2017).

Empirical studies have revealed that not only objective skills but also subjective ability beliefs influence the effective use of digital systems (Peiffer et al., 2020). Notably, self-efficacy related to digital system usage serves as a critical determinant of its

ISSN (P): 3078-5316 | ISSN (E): 3078-5324 Doi:10.71113/JCSIS.v2i5.291

effective utilization (Ulfert-Blank et al., 2022). Furthermore, competence and competence beliefs often exert independent effects on learning, motivation, and performance (Hughes et al., 2011; Marsh et al., 2017; Pajares & Schunk, 2002). Extensive research indicates that internet- and computer-related competence beliefs significantly predict individuals' capacity (Eastin & LaRose, 2000) and willingness (Venkatesh & Bala, 2008) to adopt digital technologies. Among subjective beliefs, digital self-efficacy—defined as an individual's perceived confidence in performing tasks involving digital systems—emerges as the strongest predictor of digital system engagement (Ulfert-Blank & Schmidt, 2022). Scholars globally and domestically argue that digital self-efficacy constitutes a core component of digital literacy (Ulfert-Blank & Schmidt, 2022; Wang et al., 2013).

A comprehensive understanding of the conceptual structure, cultural specificity, influencing factors, and mechanisms of adolescents' digital self-efficacy is fundamental to its scientific enhancement. Such findings are crucial for achieving the goals outlined in the 14th Five-Year Plan for National Economic and Social Development and the Long-Range Objectives Through 2035 of the People's Republic of China and advancing citizens' digital literacy.

Analysis of research status and development dynamics

Conceptual Development of Digital Self-Efficacy

Empirical studies have revealed that not only objective skills but also subjective ability beliefs influence the effective use of digital systems (Peiffer et al., 2020). Notably, self-efficacy related to digital system usage serves as a critical determinant of its effective utilization (Ulfert-Blank et al., 2022). Furthermore, competence and competence beliefs often exert independent effects on learning, motivation, and performance (Hughes et al., 2011; Marsh et al., 2017; Pajares & Schunk, 2002). Extensive research indicates that internet- and computer-related competence beliefs significantly predict individuals' capacity (Eastin & LaRose, 2000) and willingness (Venkatesh & Bala, 2008) to adopt digital technologies. Among subjective beliefs, digital self-efficacy—defined as an individual's perceived confidence in performing tasks involving digital systems—emerges as the strongest predictor of digital system engagement (Ulfert-Blank & Schmidt, 2022). Scholars globally and domestically argue that digital self-efficacy constitutes a core component of digital literacy (Ulfert-Blank & Schmidt, 2022; Wang et al., 2013).

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Measurement of Digital Self-Efficacy

Social cognitive theory emphasizes that self-efficacy measurements should focus on specific domains or tasks and reflect judgments of individual capabilities rather than social comparisons (Bandura, 2006; Marsh et al., 2017). Although the study of digital self-efficacy is relatively recent, its measurement tools have undergone several iterations. Early instruments focused on computer self-efficacy, assessing individuals' confidence in general or specific computer-related tasks. General computer self-efficacy measured confidence across diverse computing applications (Bao et al., 2013; Compeau & Higgins, 1995; Marakas et al., 1998; Weigel & Hazen, 2014), while specific computer self-efficacy targeted task-specific judgments (Marakas et al., 1998). However, these scales often fail to account for the dynamic nature of digital systems, leading to rapid obsolescence of their items (Weigel & Hazen, 2014).

With the rise of internet and communication technologies, measurement tools for internet self-efficacy (Eastin & LaRose, 2000) and ICT self-efficacy (Aesaert et al., 2017; Rohatgi et al., 2016) emerged. While these tools incorporated broader digital competencies compared to earlier computer-focused scales, they often adopted unidimensional structures, overlooking the multifaceted nature of digital literacy (Ulfert-Blank & Schmidt, 2022).

Rapid technological advancements have further complicated human-digital system interactions (Ulfert-Blank et al., 2022), exposing limitations in early measurement approaches. First, these tools neglected emerging digital competencies, such as digital security and online problem-solving. Second, their unidimensional or superficial dimensional frameworks inadequately captured the multidimensional essence of digital literacy, risking misinterpretation of scores.

Currently, the most comprehensive instrument is the Digital Self-Efficacy Scale developed by Ulfert-Blank and Schmidt (2022), based on the EU Digital Competence Framework. This 25-item scale comprises five dimensions:

1.Information and data literacy self-efficacy: Confidence in collecting, evaluating, and managing digital information.
2.Online communication and collaboration self-efficacy: Confidence in interpersonal interaction, information sharing, collaborative activities, digital etiquette, and identity management.
3.Digital content creation self-efficacy: Confidence in developing, integrating, and remixing content, handling copyrights, and programming.
4.Digital security self-efficacy: Confidence in protecting devices, personal data, privacy, health, well-being, and environmental sustainability.
5.Digital problem-solving self-efficacy: Confidence in troubleshooting technical issues, identifying needs and solutions, creatively applying digital tools, and addressing competency gaps.
While validated in European contexts, the scale's cross-cultural applicability, particularly within China's sociocultural environment, remains untested.

The Role of Digital Self-Efficacy

ISSN (P): 3078-5316 | ISSN (E): 3078-5324 Doi:10.71113/JCSIS.v2i5.291

A synthesis of existing research reveals that studies on digital self-efficacy primarily focus on two domains: (1) digital system usage and digital competence development, and (2) learning behaviors and outcomes.

1. Digital Systems and Competence Development

Empirical evidence identifies digital self-efficacy as a critical factor in shaping individuals' digital competence (Peiffer et al., 2020) and driving motivational processes (Eccles & Wigfield, 2002). Studies demonstrate that digital self-efficacy serves as a core predictor of both digital competence and subsequent digital system engagement (Deng et al., 2004; Hatlevik, 2017; Hatlevik et al., 2018; Odaci, 2013), influencing individuals' adoption of new technologies (Xie Youru et al., 2011; Ertmer et al., 1994; Hatlevik et al., 2018; Wartella & Jennings, 2000). Individuals with low digital self-efficacy exhibit reluctance and reduced likelihood of using digital systems, even when their objective digital competence is high (Hsia et al., 2014). Additionally, digital self-efficacy fosters the development of digital interaction skills (Ertmer et al., 1994; Hatlevik et al., 2018; Wartella & Jennings, 2000).

2. Learning Behaviors and Outcomes

Research indicates that digital self-efficacy predicts preferences for digital learning methods (Sun Xianhong, 2016) and correlates with learning motivation and academic performance (Chang et al., 2014; Chen, 2017; Joo et al., 2000). Teachers' digital self-efficacy also impacts their attitudes toward technology-integrated pedagogy (Yesilyurt et al., 2016) and students' information literacy (Chen, 2022). Furthermore, studies highlight its role in enhancing knowledge sharing (Shao et al., 2015; Teh et al., 2010), promoting individual agility (Maran et al., 2022), and increasing online altruistic behaviors (Liu, 2015).

Factors Influencing Digital Self-Efficacy

Digital self-efficacy is influenced by both environmental and individual factors. Environmental determinants include familial, educational, and peer-related aspects. Family factors such as household computer availability, internet access, and socioeconomic status positively correlate with digital self-efficacy (Liao et al., 2016). In educational settings, teacher support enhances digital self-efficacy (Chen, 2022), while peer support similarly contributes to its development (Hsiao et al., 2012). At the individual level, personality traits, cognitive abilities, and emotional states play significant roles. Openness to experience (Maran et al., 2022) and computational thinking skills (Liao et al., 2022) are positively associated with digital self-efficacy. Emotionally, higher emotional stability correlates with stronger digital self-efficacy (Maran et al., 2022), whereas computer anxiety negatively impacts computer-related self-efficacy (Sun Xianhong, 2017). Conversely, enjoyment of programming fosters digital self-efficacy (Liao et al., 2022). These findings collectively highlight the multifaceted interplay of contextual and personal elements in shaping individuals' confidence in navigating digital environments.

Current Research Gaps

While digital self-efficacy and digital competence independently influence the effective use of digital systems, research on digital self-efficacy remains underexplored compared to digital competence. Key gaps include:

Conceptual Ambiguity and Structural Underdevelopment

The conceptualization of digital self-efficacy lags behind advances in digital competence frameworks. Digital competence has evolved from narrow definitions (e.g., information retrieval and content creation; Jin et al., 2020; Siddiq et al., 2016) to multidimensional constructs, notably the European Commission's framework encompassing five dimensions: information and data literacy, communication and collaboration, digital content creation, digital security, and problem-solving (Carretero et al., 2017; Ulfert-Blank & Schmidt, 2022). This framework has gained cross-cultural validation (Law et al., 2018). In contrast, digital self-efficacy research predominantly employs oversimplified unidimensional measures (e.g., Guo et al., 2019; Hatlevik & Bjarnø, 2021; Kuo & Belland, 2019; Spears & Zheng, 2020; Zhang et al., 2020). Even multidimensional studies often lack theoretical depth, relying on superficial distinctions like "basic vs. advanced" computer self-efficacy (Kim & Glassman, 2013; Liang et al., 2011). The recent multidimensional framework by Ulfert-Blank and Schmidt (2022), mirroring the EU's digital competence model, remains understudied in its structural logic and untested in non-Western contexts, including China.

Cultural and Measurement Limitations

Despite early contributions from mainland Chinese scholars (e.g., Li, 2004; Tang & Yan, 2004; Wang, 2010; Yang & Li, 2010; Zhong & Liu, 2007), current research in China continues to rely on outdated constructs like computer self-efficacy or ICT self-efficacy (e.g., Sun, 2017; Wu & Wu, 2017; Li et al., 2019). No studies explicitly addressing digital self-efficacy exist in the Web of Science Core Collection (see Table 3). The absence of a culturally adapted measurement tool and a clear conceptual framework impedes progress in understanding the mechanisms of digital self-efficacy in Chinese populations, hindering efforts to enhance positive digital behaviors and mitigate negative usage patterns.

Unclear Cultural Specificity of Digital Self-Efficacy

The indigenous characteristics of digital self-efficacy remain underexplored. Current studies predominantly employ oversimplified (e.g., Guo et al., 2019; Hatlevik & Bjarnø, 2021) or superficial dimensional frameworks (e.g., Kim & Glassman,

ISSN (P): 3078-5316 | ISSN (E): 3078-5324 Doi:10.71113/JCSIS.v2i5.291

2013; Liang et al., 2011), leaving latent typologies of digital self-efficacy unexamined. Identifying such typologies is critical for comparing influencing factors and mechanisms across subgroups and tailoring interventions to enhance digital literacy. Developmental trajectories are also poorly understood. Existing studies focus on homogeneous samples (e.g., elementary students: Li et al., 2022; Aesaert et al., 2017; college students: Kuo & Belland, 2019) or short-term longitudinal designs (<1 year; Nelissen, 2019). While cross-sectional studies suggest age positively correlates with digital self-efficacy (Kuo & Belland, 2019; Wu & Tsai, 2006), longitudinal evidence is insufficient to infer developmental patterns or critical periods. Cultural heterogeneity in age-related effects (Peterson, 1993; Li et al., 2016) further underscores the need for context-specific investigations into Chinese adolescents' digital self-efficacy trajectories.

Fragmented Understanding of Influencing Factors

Despite identifying environmental (e.g., family resources, teacher support) and individual (e.g., personality, cognitive skills) predictors, research lacks a systemic framework to integrate these factors. Theoretical models are needed to elucidate hierarchical or interactive relationships among determinants.

Underexplored Formation and Impact Mechanisms

Research on digital self-efficacy formation faces four key limitations. First, conceptual oversimplification persists, with most studies treating the construct as unidimensional (e.g., Kuo & Belland, 2019), thereby masking dimension-specific mechanisms. Second, reliance on legacy constructs like computer or internet self-efficacy (e.g., Choi et al., 2022; Hong et al., 2021) limits generalizability to modern multidimensional frameworks. Third, environmental influences remain narrowly focused, neglecting macro-level factors (e.g., cultural norms) and peripheral contexts (e.g., community networks). Fourth, methodological constraints dominate, as cross-sectional designs (e.g., Hammer et al., 2021) hinder causal inference, while longitudinal and experimental approaches are rare.

Regarding impact mechanisms, studies predominantly emphasize generic digital system usage and academic outcomes, overlooking critical domains such as online prosociality, cyberbullying prevention, and victimization resilience—areas theoretically linked to digital self-efficacy through frameworks like Bronfenbrenner's ecosystem theory and bystander intervention models (Levine et al., 2005; Knauf, 2018). Additionally, developmental research disproportionately targets teachers (Sun, 2017; Wu & Wu, 2017) and college students (Huang et al., 2013; Wang, 2010), neglecting adolescents, a pivotal group for advancing national digital literacy. Global studies exhibit similar biases, underscoring the urgency of broadening both thematic and demographic scopes in future investigations.

Insufficient Empirical Research on Interventions

Randomized controlled trials (RCTs) are essential for evaluating interventions targeting digital self-efficacy. While correlational and longitudinal studies on digital self-efficacy abound, empirical intervention research remains scarce, with limited rigorous assessments of efficacy. Although studies on general self-efficacy interventions (e.g., Bresó et al., 2011; Siegel et al., 2022) have identified effective strategies, their applicability to digital self-efficacy—including operational adaptations and outcome generalizability—requires further empirical validation.

Conclusion

In summary, while research on digital self-efficacy in China commenced early, current domestic studies employ outdated conceptual frameworks, structural models, and measurement tools that fail to align with global advancements. The applicability of recent international findings to China's cultural specificity remains unverified. Existing research also neglects the indigenous and developmental characteristics of Chinese adolescents' digital self-efficacy. Both domestic and international studies lack systematic exploration of its formation mechanisms and exhibit limitations in understanding its impacts. To address these gaps, this project proposes a comprehensive investigation grounded in ecological systems theory, focusing on (1) the conceptual structure and internal logic of adolescents' digital self-efficacy in China, (2) its cultural distinctiveness and influencing factors, (3) developmental continuity and critical phases, (4) formation and impact mechanisms, and (5) the efficacy of educational interventions. These findings will advance efforts to achieve the goals outlined in the 14th Five-Year Plan for National Economic and Social Development and the Long-Range Objectives Through 2035 of the People's Republic of China and enhance citizens' digital literacy.

Acknowledgment

All contributions of the third parties can be acknowledged in this section.

Conflict of Interest

The authors have no conflicts of interest to declare that are relevant to the content of this article.

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ISSN (P): 3078-5316 | ISSN (E): 3078-5324 Doi:10.71113/JCSIS.v2i5.291

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