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DIGITAL EDUCATION TRANSFORMATION AND PROBLEMATIC GADGET USE: IMPLICATIONS FOR SDG 4 AND THE ROLE OF MINANGKABAU LOCAL WISDOM IN INDONESIA

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Abstract
Digital transformation has expanded the possibilities for educational access, communication, and learning resource development. Yet, the educational value of connected devices depends on how, why, and under what conditions they are used. This critical narrative review examines the relationship between digital education transformation, problematic gadget use among school-age learners, and the implications for Sustainable Development Goal 4 (SDG 4), with particular attention to the potential contribution of Minangkabau local wisdom expressed in the philosophy Adat Basandi Syarak, Syarak Basandi Kitabullah (ABS-SBK). The review synthesizes literature on problematic smartphone use, learning and attention, digital literacy, school-based technology integration, parental mediation, and culturally grounded character education. The literature indicates that educational technology is not inherently beneficial or harmful: purposeful, teacher-guided use can support learning, whereas off-task, prolonged, and poorly regulated use is associated with distraction and less favourable academic and psychosocial outcomes. These relationships are shaped by individual self-regulation, family practices, school norms, and unequal access to supportive learning environments. The review maps these concerns onto SDG 4 targets 4.1, 4.4, and 4.7 and argues that progress should be assessed not by device access alone but by the quality, equity, safety, and educational relevance of digital participation. It proposes a context-sensitive framework combining digital literacy, pedagogical mediation, family–school partnership, and ABS-SBK-informed ethical reflection. Because the study is a narrative review rather than a systematic review or empirical investigation, the framework should be treated as a conceptual proposition requiring validation in diverse Indonesian educational settings.

Keywords: digital education, problematic smartphone use, digital well-being, SDG 4, digital literacy, Minangkabau local wisdom

Abstrak
Transformasi digital telah memperluas peluang untuk akses pendidikan, komunikasi, dan pengembangan sumber daya pembelajaran. Namun, nilai pendidikan dari perangkat yang terhubung bergantung pada bagaimana, mengapa, dan dalam kondisi apa perangkat tersebut digunakan. Tinjauan naratif kritis ini mengkaji hubungan antara transformasi pendidikan digital, penggunaan gawai yang bermasalah di kalangan peserta didik usia sekolah, serta implikasinya terhadap Tujuan Pembangunan

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*Berkelanjutan 4 (SDG 4). Kajian ini memberikan perhatian khusus pada potensi kontribusi kearifan lokal Minangkabau yang tercermin dalam filosofi *Adat Basandi Syarak, Syarak Basandi Kitabullah* (ABS-SBK). Tinjauan ini menyintesis literatur mengenai penggunaan ponsel pintar yang bermasalah, pembelajaran dan perhatian, literasi digital, integrasi teknologi di sekolah, mediasi orang tua, serta pendidikan karakter yang berakar pada budaya. Literatur menunjukkan bahwa teknologi pendidikan tidak serta-merta bermanfaat atau merugikan; penggunaan yang terarah dan dibimbing oleh guru dapat mendukung pembelajaran, sementara penggunaan yang tidak relevan dengan tugas, berlebihan, dan kurang diatur justru dikaitkan dengan gangguan konsentrasi serta hasil akademik dan psikososial yang kurang optimal. Hubungan ini dipengaruhi oleh regulasi diri individu, praktik dalam keluarga, norma sekolah, dan ketimpangan akses terhadap lingkungan belajar yang mendukung. Tinjauan ini mengaitkan berbagai persoalan tersebut dengan target 4.1, 4.4, dan 4.7 dalam SDG 4, serta berargumen bahwa kemajuan tidak boleh hanya diukur dari akses terhadap perangkat, melainkan dari kualitas, kesetaraan, keamanan, dan relevansi pendidikan dalam partisipasi digital. Studi ini mengusulkan kerangka kerja yang peka terhadap konteks, yang memadukan literasi digital, mediasi pedagogis, kemitraan keluarga-sekolah, dan refleksi etis yang berlandaskan pada filosofi ABS-SBK. Mengingat studi ini merupakan tinjauan naratif—bukan tinjauan sistematis ataupun investigasi empiris—kerangka kerja yang diusulkan harus dipandang sebagai proposisi konseptual yang memerlukan validasi lebih lanjut dalam berbagai lingkungan pendidikan di Indonesia.*
Kata kunci: *pendidikan digital, penggunaan ponsel pintar yang bermasalah, kesejahteraan digital, SDG 4, literasi digital, kearifan lokal Minangkabau*

INTRODUCTION

Digital technologies have become embedded in contemporary education, changing how teachers design instruction, how learners access information, and how schools communicate and manage learning. Digital platforms can widen access to learning resources, support flexible forms of participation, and provide opportunities to develop digital competencies. However, the presence of devices does not automatically improve educational quality. Technology contributes to learning only when it is aligned with instructional purposes, learner needs, teacher capacity, and the wider conditions of educational provision (UNESCO, 2023; Tondeur et al., 2012). The central policy question is therefore not whether schools should use technology, but under what conditions technology serves educational purposes and protects learners' well-being.

This distinction is important in Indonesia, where the expansion of internet connectivity and personal mobile-device ownership has occurred alongside concerns about young people's screen practices. The original manuscript reports national figures from APJII, Statistics Indonesia, and other institutional sources to illustrate the scale of device access. Those figures should be interpreted cautiously: access or ownership is not equivalent to problematic use, and estimates vary according to age group, survey design, and the definition of device use. A more analytically useful distinction is between purposeful educational use and patterns of use that interfere with sleep, attention, relationships, or everyday responsibilities. National reports document the expansion of internet access and

mobile-device ownership (APJII, 2023; Badan Pusat Statistik, 2024), although these indicators should not be interpreted as measures of problematic use.

The term gadget addiction is widely used in public discourse, but it can overstate the diagnostic status of the phenomenon. Research more commonly uses terms such as problematic smartphone use (PSU), problematic mobile-phone use, or problematic internet use. These constructs describe patterns involving impaired control, preoccupation, withdrawal-like experiences, tolerance-like escalation, and functional impairment; they should not be treated as a clinical diagnosis solely on the basis of high screen time (Kwon et al., 2013a, 2013b; Rosenberg & Feder, 2014). Accordingly, this article uses problematic gadget use as an umbrella expression and reserves addiction for discussion of the terminology used in specific studies.

The educational consequences of digital-device use are also more nuanced than a simple positive–negative dichotomy. A meta-analysis of adolescent studies found that the relationship between device use and academic performance varied according to purpose and context: educational use was positively associated with performance, whereas entertainment, social networking, gaming, and longer duration were negatively associated (Wang et al., 2024). A separate meta-analysis reported an overall negative association between problematic smartphone use and academic achievement (Paterna et al., 2024). OECD evidence similarly indicates that digital distraction in mathematics lessons is associated with lower performance, while intentional integration of technology can support learning (OECD, 2023).

These issues intersect with SDG 4, which calls for inclusive, equitable, and quality education and lifelong learning opportunities. In particular, target 4.1 concerns effective learning outcomes and completion of quality primary and secondary education; target 4.4 concerns relevant skills, including digital skills; and target 4.7 concerns knowledge and skills for sustainable development, human rights, global citizenship, and appreciation of cultural diversity (United Nations, 2015). Problematic device use does not, by itself, determine whether these targets will be achieved. Rather, it may become one risk factor within broader educational systems when it undermines attention, participation, well-being, or the development of responsible digital citizenship.

A further issue concerns the cultural and ethical foundations of digital participation. In West Sumatra, the Minangkabau philosophy ABS-SBK expresses a relationship between customary norms and Islamic principles. Existing scholarship discusses its relevance to education and character formation (Akhyar et al., 2023; Albert et al., 2022; Fajria & Fitrisia, 2024). This article considers ABS-SBK not as a substitute for evidence-based digital education or a universal solution to problematic use, but as a locally meaningful ethical resource that may support reflection, responsibility, self-regulation, and community care.

The article addresses three questions: (1) how should problematic gadget use be understood in the context of digital education transformation; (2) through what pathways

may problematic use challenge learning and selected SDG 4 targets; and (3) how might digital literacy, pedagogical and parental mediation, and Minangkabau local wisdom be integrated into a context-sensitive response? Its contribution is a conceptual synthesis that connects digital well-being with the educational purposes of SDG 4 and proposes a culturally situated framework for further empirical testing.

METHOD

This article adopts a critical narrative literature-review approach. It synthesizes conceptual and empirical publications concerning digital education, problematic smartphone or internet use among adolescents, academic and psychosocial outcomes, digital literacy, parental mediation, and Minangkabau character education. The source manuscript identified journal articles, books, and institutional reports and described the use of content analysis to identify recurring concepts and findings. The present revision clarifies the scope and analytical logic of that approach but does not recast it as a systematic review.

The synthesis is organized around four analytical domains: (a) conceptual definitions and dimensions of problematic device use; (b) individual, family, and contextual factors associated with problematic use; (c) implications for learning, well-being, and SDG 4; and (d) educational responses, including culturally grounded character education. Sources were considered relevant when they addressed one or more of these domains and offered conceptual, empirical, or policy insight. International research is used to situate the Indonesian discussion, while Indonesian publications and institutional documents provide contextual grounding. The approach follows the general logic of library-based inquiry described by Zed (2014), while retaining the limitations of the source manuscript's undocumented search procedures.

A methodological limitation must be made explicit. The source manuscript does not report the databases searched, exact search strings, search dates, duplicate-removal procedures, screening counts, or a formal quality-appraisal protocol. Consequently, the review cannot claim exhaustive coverage, reproducible systematic searching, or PRISMA compliance. The findings are therefore presented as a reasoned narrative synthesis rather than a quantitative estimate of prevalence or causal effect. Future work should report a transparent search protocol and, where appropriate, use systematic or scoping-review methods.

RESULTS AND DISCUSSION

Conceptualising Problematic Gadget Use

From screen time to functional impairment

Screen time is a descriptive measure of duration, not a diagnosis. Two learners may spend the same amount of time on a smartphone but have substantially different experiences: one may use it for structured learning, communication with teachers, or creative production, while another may engage in repetitive checking or prolonged off-task

activity that disrupts sleep and schoolwork. Assessment should therefore consider purpose, context, degree of control, and functional consequences rather than duration alone (UNESCO, 2023; Wang et al., 2024).

The Smartphone Addiction Scale–Short Version developed by Kwon et al. (2013b) operationalizes problematic use through dimensions including daily-life disturbance, positive anticipation, withdrawal, cyberspace-oriented relationships, overuse, and tolerance. These dimensions can help researchers identify patterns that warrant attention, but a screening score should not be interpreted as a clinical diagnosis without appropriate professional assessment. The distinction matters in school settings, where labels can stigmatize learners and obscure the educational, family, or psychosocial conditions contributing to their behaviour.

Individual, family, and contextual correlates

Problematic use is better understood as a multidimensional phenomenon than as a failure of individual discipline. Individual correlates may include difficulties with self-regulation, coping, boredom, and emotional distress. Situational conditions can make a device attractive as an immediate source of stimulation or relief. Social factors, including peer communication expectations and the design of online platforms, can reinforce repeated checking and prolonged engagement. Family context and parental mediation also matter. A systematic review found that parental mediation practices are associated with adolescents' problematic online screen use, although the relationships vary by mediation strategy and outcome (Nielsen et al., 2019). Earlier Indonesian work has also discussed mobile-phone dependency and individual, situational, social, and external correlates (Yuwanto, 2010).

Family monitoring should not be reduced to punitive restriction. Open communication, co-use, discussion of online experiences, consistent boundaries, and parental modelling may help adolescents develop autonomous regulation. Evidence also points to associations between parental smartphone monitoring, self-efficacy, self-control, and problematic smartphone use (Sun et al., 2022). These findings support a relational approach in which parents guide rather than simply police young people's digital behaviour.

Educational use and non-educational use

The distinction between educational and recreational use is central. Digital tools can facilitate access to resources, collaboration, feedback, and the development of digital skills. Conversely, notifications, social media, gaming, and multitasking can compete with instructional attention. Wang et al. (2024) found that the association between device use and academic performance differed according to purpose and setting. This evidence cautions against policies that equate all device use with distraction or, conversely, assume that all technology integration is pedagogically beneficial.

The appropriate unit of analysis is therefore not the device itself but the interaction among learner, task, teacher, platform, and learning environment. School policies should distinguish planned instructional use from off-task use, specify when devices are needed, and provide clear routines for notifications, storage, and classroom transitions.

Educational and SDG 4 Implications

Learning attention, academic engagement, and target 4.1

Target 4.1 emphasizes that all learners should complete quality primary and secondary education and achieve relevant learning outcomes. Problematic device use may challenge this target when it contributes to fragmented attention, reduced time on task, sleep disruption, procrastination, or lower engagement. A meta-analysis reported a negative association between problematic smartphone use and academic achievement (Paterna et al., 2024). OECD analyses also report that students who experience frequent digital distraction in mathematics lessons tend to perform less well than peers who report less distraction (OECD, 2023).

These findings do not establish that smartphone use alone causes poor achievement. Academic performance is influenced by socioeconomic conditions, prior attainment, teaching quality, school climate, mental health, and access to learning resources. The defensible conclusion is that off-task and poorly regulated use can be a relevant risk factor, while purposeful educational use may support learning. Educational interventions should therefore target the conditions and patterns of use rather than device ownership as such.

Digital competence and target 4.4

Target 4.4 calls for an increase in the number of young people and adults with relevant skills, including technical and vocational skills, for employment and entrepreneurship. Digital competence is broader than operational familiarity with devices. It includes the ability to search for and evaluate information, communicate responsibly, create digital content, protect privacy, understand online risks, and use technology to solve problems. A learner who spends many hours online does not necessarily possess these competencies.

Digital literacy initiatives should therefore move beyond technical training toward critical, ethical, and participatory forms of competence. The Indonesian digital literacy movement has emphasized the need to develop capacities across multiple dimensions of digital participation (Kurnia et al., 2017). Teachers play a central role in designing activities that require learners to evaluate sources, collaborate, create, and reflect, rather than merely consume information.

Character, citizenship, and target 4.7

Target 4.7 includes education for sustainable development, human rights, gender equality, a culture of peace and non-violence, global citizenship, and appreciation of cultural diversity. Digital environments can expand access to diverse perspectives, but they can also expose learners to misinformation, harmful communication, cyberbullying, and

patterns of consumption that conflict with responsible citizenship. The educational response should not be moral panic about technology; it should build the ethical judgement and social responsibility needed to participate safely and constructively.

Concerns about academic dishonesty, procrastination, and weakened responsibility should be addressed through explicit instruction in academic integrity, time management, online communication, and responsible participation. Research on academic dishonesty among Indonesian university students demonstrates the relevance of moral reasoning and moral disengagement to integrity-related behaviour (Ampuni et al., 2020). Although university findings should not be generalized directly to school-age children, they reinforce the need to treat digital ethics as an educational competency.

Equity, inclusion, and digital well-being

Digital transformation may reproduce inequality when learners differ in device quality, connectivity, accessible content, parental support, or teacher guidance. The UNESCO Global Education Monitoring Report emphasizes that technology decisions should be judged in relation to relevance, equity, scalability, and sustainability, and that educational technology should support rather than displace human interaction (UNESCO, 2023). Accordingly, a school-level response must avoid assuming that all learners have the same resources or that restrictive policies have equal effects on every household.

Digital well-being should be understood as the capacity to use digital environments in ways that support learning, health, agency, relationships, and participation. This includes attention to sleep, physical activity, emotional regulation, privacy, and respectful interaction. Policies that focus exclusively on reducing screen time may miss these broader dimensions and may also penalize learners who depend on devices for legitimate educational access. Age-specific guidance is essential: the WHO (2019) document cited in the source manuscript concerns children under five and should not be used to claim a universal two-hour daily screen-time limit for adolescents.

A Context-Sensitive Response: Digital Literacy, Mediation, and ABS-SBK

Three mutually reinforcing educational strategies

First, schools should implement comprehensive digital literacy education. Learners need opportunities to practise source evaluation, privacy protection, cyber-safety, digital communication, content creation, and reflective management of attention. Activities such as device-free learning intervals may be useful when they are pedagogically justified, but they should not be presented as universally effective interventions without evaluation. The objective is purposeful and self-regulated use, not the rejection of technology.

Second, teachers should act as pedagogical mediators of technology. Technology integration requires alignment among learning objectives, instructional methods, assessment, and the characteristics of learners. Research on teacher preparation emphasizes the importance of preparing teachers to integrate technology pedagogically rather than treating it as an add-on (Tondeur et al., 2012). Teachers can establish explicit

norms for classroom device use, design tasks that require active engagement, model critical evaluation of digital information, and identify patterns of distraction that may require supportive conversations.

Third, schools should build family–school partnerships around digital parenting. Parents and caregivers can support consistent routines, discuss online experiences, model balanced device use, and negotiate age-appropriate boundaries. School guidance should recognize differences in family resources and avoid placing the entire responsibility for digital well-being on parents. The evidence on parental mediation suggests that supportive and communicative practices deserve attention alongside restrictive controls (Nielsen et al., 2019; Sun et al., 2022).

ABS-SBK as a locally grounded ethical resource

ABS-SBK is commonly expressed as the principle that Minangkabau customary life is grounded in Islamic teachings and that Islamic teachings are grounded in the Qur'an. The philosophy is a culturally situated moral framework rather than a standardized psychological intervention. Literature reviews and educational studies have discussed its place in Minangkabau identity, curriculum, and character formation (Akhyar et al., 2023; Albert et al., 2022; Fajria & Fitrisia, 2024).

For digital education, ABS-SBK may provide a vocabulary for discussing responsibility, moderation, respect, honesty, care for others, and accountability. Its potential contribution is not to prescribe a single screen-time limit but to support learners' reflection on whether their digital actions are consistent with ethical and communal responsibilities. This approach can be connected to digital citizenship education, including respectful communication, avoidance of harmful content, academic honesty, and care for the consequences of online behaviour.

The philosophy Alam Takambang Jadi Guru, which encourages learning from the surrounding world, can also be used as a pedagogical prompt for critical inquiry into the effects of technology on personal, family, and community life (Satria & Sahayu, 2022). Learners may examine how digital tools support learning, when they become distracting, and how online conduct affects relationships. Such activities should be developed collaboratively with local educators and communities to avoid reducing a living cultural tradition to a superficial classroom slogan.

Proposed integrative framework

The review proposes a four-layer framework in which the learner is supported by coordinated individual, pedagogical, family, and cultural conditions. The framework is conceptual and has not yet been empirically tested. Its components and expected functions are summarized in Table 1.

LAYER	CORE COMPONENTS	INTENDED EDUCATIONAL FUNCTION
LEARNER SELF-REGULATION	Awareness of purpose; attention management; reflective use; help-seeking	Support autonomy and reduce disruptive patterns of use
PEDAGOGICAL MEDIATION	Task-aligned technology; classroom norms; critical digital literacy; teacher modelling	Ensure technology serves learning objectives and target 4.4
FAMILY–SCHOOL PARTNERSHIP	Open communication; negotiated boundaries; parental modelling; coordinated support	Promote consistent expectations and learner well-being
CULTURAL-ETHICAL GROUNDING	ABS-SBK values; responsibility; honesty; moderation; respect; community care	Connect digital citizenship with locally meaningful ethical reflection and target 4.7

The framework assumes reciprocal rather than one-way influence. Learners' self-regulation is shaped by classroom expectations, family practices, peer norms, and access conditions. Teachers and parents, in turn, need institutional guidance and culturally responsive resources. ABS-SBK is positioned as an ethical interpretive resource within this ecology, not as a replacement for psychological assessment, safeguarding procedures, or evidence-based educational practice.

DISCUSSION

The synthesis suggests that the key challenge for Indonesian education is not the mere presence of gadgets but the governance of digital participation. A technology-centred approach measures success through connectivity, devices, and platform adoption. An educationally grounded approach asks whether technology improves learning, strengthens digital competence, protects well-being, and expands equitable participation. This distinction is consistent with UNESCO's argument that technology should be evaluated in relation to educational purpose and learner needs (UNESCO, 2023). This interpretation also aligns with the broader argument that digital technologies should be selected and governed according to educational relevance rather than novelty or availability alone (UNESCO, 2023).

The evidence also challenges the assumption that more screen time necessarily means greater digital competence. The relationship between device use and academic performance depends on purpose, context, and duration (Wang et al., 2024). Thus,

schools should avoid simplistic blanket claims that gadgets are either inherently beneficial or inherently harmful. Instead, they should develop differentiated policies: devices may be required for specific learning tasks, while non-instructional use may be restricted during periods that require sustained attention.

The proposed integration of ABS-SBK adds a contextual dimension to debates often framed primarily through individual self-control or parental restriction. By connecting digital conduct with responsibility, honesty, moderation, and care for the community, local wisdom may help make digital citizenship meaningful to learners and families. Nevertheless, this proposal requires careful empirical examination. It should not assume that all learners identify with Minangkabau values or that one cultural framework can be transferred unchanged to culturally diverse Indonesian schools. In plural settings, culturally grounded education should be dialogical, inclusive, and attentive to students' different backgrounds.

For policy and practice, three implications follow. At the school level, digital literacy should be integrated across subjects and accompanied by clear, proportionate classroom routines. At the family level, schools should provide practical guidance on supportive mediation rather than relying solely on prohibition. At the curriculum and community level, locally grounded ethical resources may be incorporated through dialogue and reflective learning. These actions should be evaluated using outcomes such as on-task engagement, information-evaluation skills, perceived digital well-being, academic integrity, and learner participation—not simply reductions in total screen time.

The article's conceptual contribution is to connect problematic gadget use with the quality dimension of SDG 4 while retaining the enabling potential of digital technology. It also proposes a multilevel response in which self-regulation, pedagogy, family mediation, and cultural ethics are mutually reinforcing. This framework offers a basis for empirical research, including school-based studies that examine how culturally responsive digital citizenship programmes are designed, implemented, and evaluated.

Limitations and Future Research

This review has several limitations. First, it is a critical narrative review and does not provide a systematic, exhaustive search of all relevant literature. Second, the source manuscript contains some national statistics and secondary citations for which the original survey instruments, sampling frames, and definitions are not fully documented. Such figures should be independently checked against original institutional reports before publication. Third, the literature on problematic smartphone use includes heterogeneous constructs and measures, making direct comparisons difficult. Fourth, the ABS-SBK framework is proposed conceptually; its acceptability, educational feasibility, and outcomes have not been tested in a controlled or longitudinal study.

Future research should use transparent scoping or systematic review procedures to map the evidence base. Empirical studies in Indonesian schools could examine the relationship among purpose of device use, self-regulation, classroom norms, family mediation, and

learning outcomes. Intervention studies could test digital literacy and culturally responsive character-education programmes using validated measures and appropriate comparison designs. Researchers should also examine how ABS-SBK-informed approaches can be adapted for diverse learners without imposing a single cultural identity or religious interpretation.

CONCLUSION

Digital transformation offers important opportunities to widen educational access and develop relevant digital competencies, but its contribution to quality education depends on purposeful and equitable implementation. Problematic gadget use may undermine attention, academic engagement, well-being, and responsible participation, yet device use should not be treated as uniformly harmful. The evidence indicates that purpose, context, duration, self-regulation, and pedagogical guidance shape the relationship between digital technology and learning.

In relation to SDG 4, the central task is to ensure that technology supports learning outcomes (target 4.1), meaningful digital competencies (target 4.4), and ethical, culturally responsive citizenship (target 4.7). This article proposes an integrated response combining comprehensive digital literacy, teacher mediation, family–school partnership, and ABS-SBK-informed ethical reflection. ABS-SBK may provide a locally meaningful resource for cultivating responsibility, moderation, honesty, and community care, but its educational value requires inclusive implementation and empirical validation. The proposed framework should therefore be understood as a conceptual contribution and a research agenda, not as an established intervention with demonstrated causal effects.

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