Journal of Contemporary Educational Research, 2026, Volume 10, Issue 8
http://ojs.bbwpublisher.com/index.php/JCER
Online ISSN: 2208-8474
Print ISSN: 2208-8466

Data-Driven Decision-Making and Transformation of School Management: A Qualitative Case Study on the Integration of Educational Artificial Intelligence

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Abstract: In the contemporary landscape of global educational reform, the integration of educational data mining, smart campus infrastructures, and artificial intelligence into institutional governance represents a fundamental paradigm shift. Set against the strategic backdrop of China's push toward digital educational transformation and the modernization of its educational governance capabilities, this research investigates the systemic transition from traditional heuristic administration to evidence-based, data-driven decision-making. As the vanguard institution of the R Primary School Education Group, T Primary School has navigated the complex intersection of advanced data analytics and its deeply humanistic "Renhe" (people-oriented harmony) cultural philosophy. Through an in-depth thematic analysis of institutional practices, leadership directives, and localized pedagogical frictions, this study elucidates how data-driven frameworks are operationalized in curriculum development, continuous formative evaluation, and cognitive-behavioral tracking. The findings reveal that while quantitative data systems significantly optimize resource allocation and enable personalized learning pathways, they are inherently insufficient without qualitative human contextualization. The study highlights profound epistemological and organizational challenges, including stakeholder resistance, the limitations of purely quantitative metrics in capturing student motivation, and the ethical imperatives of privacy within distributed collective decision-making models. Ultimately, this report proposes a transition from rigid "data-driven" mandates to nuanced "data-informed" leadership ecosystems, offering critical theoretical and practical implications for the deployment of trustworthy AI and educational large models in modern school governance.

Keywords: Data-driven decision-making; Educational data mining; Smart campus governance; Trustworthy AI in education

Online publication: August 31, 2026

1. Introduction

The advent of the big data era has precipitated structural transformations across numerous socio-economic and institutional domains, with the educational sector standing at the precipice of a profound pedagogical and administrative paradigm shift. This transformation is acutely relevant within the context of national and international strategic imperatives. In alignment with the strategic demands of digital transformation—exemplified by policy frameworks such as China's *The Outline Plan for the Development of the Education Sector During the 15th Five-Year Plan Period (2026–2030)*—the enhancement of educational governance capabilities through data has become a definitive, non-negotiable mandate. Strategic frameworks explicitly encourage institutions to leverage big data, artificial intelligence, and virtual reality to revolutionize instructional modes, perfect the top-level design of educational administration, and ensure the equitable distribution of high-quality educational resources [1]. Consequently, the discourse surrounding educational modernization has inextricably linked the utilization of comprehensive data systems with the modernization of primary and secondary school governance.

Educational decision-making fundamentally involves the allocation of finite resources, the design of responsive curricula, and the implementation of pedagogical interventions tailored to meet specific developmental needs [2]. This research report presents an exhaustive qualitative instrumental case study of T Primary School, the flagship institution of the R Primary School Education Group established in 2017. Through this detailed case analysis, this report seeks to address several critical, intersecting inquiries. First, under what historical and cultural catalysts did T Primary School initiate its data-driven transformation, and how did executive leadership foster organizational buy-in? Second, how are data-centric strategies operationally manifested in curriculum design, intelligent tutoring systems, and macro-level smart campus improvements? Third, what organizational frictions, epistemological limitations, and operational challenges emerge when a deeply humanistic educational environment interfaces with rigid algorithmic systems and distributed governance models? By critically examining these dimensions, this report provides nuanced, second-order insights into the future of modern educational governance, offering a critical roadmap for the ethical and effective deployment of trustworthy AI in education.

2. Theoretical framework and literature review

The conceptual architecture of this study is anchored at the nexus of four established and rapidly evolving theoretical domains: Data-Driven Decision-Making (DDDM) in educational leadership, Educational Data Mining (EDM) and Learning Analytics, and Smart Campus Infrastructure. The synthesis of these frameworks provides the necessary academic scaffolding to interpret the qualitative phenomena observed at T Primary School.

2.1. The maturation of data-driven decision-making in education

Data-driven decision-making in educational leadership refers to the systematic collection, analysis, examination, and interpretation of diverse datasets—ranging from academic performance and formative assessments to behavioral, demographic, and operational metrics—to inform policy and instructional practices [3]. Over the past two decades, DDDM has evolved from the basic aggregation of standardized summative test scores into a highly sophisticated practice utilizing real-time dashboards, behavioral tracking, and predictive analytics. The ultimate objective of DDDM is to move away from administrative conclusions based on undefined intuition or anecdotal evidence toward evidence-based strategies that accurately identify learning gaps, measure the efficacy of interventions, and promote systemic educational equity.

However, contemporary educational literature increasingly differentiates between being purely "data-driven" and being "data-informed." A strictly data-driven approach risks reducing complex, multifaceted human behaviors, cognitive struggles, and emotional states to mere numerical variables [4]. This reductionism is particularly perilous in the context of artificial intelligence; if AI systems and predictive algorithms are trained on biased historical data, a purely data-driven approach may inadvertently perpetuate or exacerbate structural inequalities, such as disproportionately recommending lower-level remedial materials to marginalized student populations. Conversely, a data-informed approach treats quantitative metrics as one of many vital tools, deliberately creating space for qualitative context, human judgment, and educator experience. Balancing quantitative aggregates with qualitative insights—such as teacher observations, student interviews, and an understanding of the prevailing school culture—is vital for ethical, effective, and trustworthy leadership [5].

2.2. Educational data mining and learning analytics

Educational Data Mining (EDM) is a multidisciplinary research area that applies advanced data mining techniques, machine learning algorithms, and statistical analysis to the unique, highly structured, and unstructured types of data generated within educational settings [6]. The overarching goal of EDM is to discover pedagogically relevant knowledge that can validate learning theories at scale, predict student knowledge states, identify at-risk populations before failure occurs, and facilitate highly adaptive, personalized learning environments.

The application of advanced data analytics in educational management operates on several interconnected levels, which must be clearly delineated to understand their respective impacts on institutional governance. The distinct operational scopes of these analytical paradigms are summarized in **Table 1**.

Table 1. The distinct operational scopes of the analytical paradigms

Analytical paradigm	Primary focus and data sources	Strategic objective in educational management
Educational Data Mining (EDM)	Determinants of the learning process (e.g., clickstreams, sensor data, digital trails, system usage logs).	Understanding complex learning patterns, building automated cognitive models, and facilitating adaptive, intelligent tutoring systems.
Learning Analytics (LA)	Determinants of student achievement (e.g., formative assessments, assignment quality, quiz results) [7].	Informing direct instructional decisions, enhancing pedagogical design, adjusting lesson pacing, and predicting academic outcomes.
Academic Analytics (AcAn)	Organizational-level determinants (e.g., enrollment trends, resource allocation, budget reports, staffing levels).	Providing actionable intelligence for principals and administrators regarding institutional operations, policy development, and strategic planning [8].

As educational technology evolves, the granularity of data collected has increased dramatically, shifting from simple administrative records to highly unstructured inputs such as free-form essays, discussion board interactions, and even affect-sensor data that tracks student attention and emotional states on a second-by-second basis. This micro-level data collection is foundational for the development of adaptive learning technologies and educational large models, which rely on vast, multidimensional datasets to personalize instruction dynamically.

2.3. Smart campus governance architectures

The realization of continuous EDM and real-time Learning Analytics relies heavily on the physical and digital infrastructure of a "Smart Campus" [9]. A smart campus integrates Internet of Things (IoT) sensors, cloud computing platforms, advanced data analytics, and mobile applications to create a frictionless, interconnected educational ecosystem. Modern smart campus data models are inherently layered, typically comprising data acquisition hardware, processing and storage facilities, analytics and decision-support mechanisms, and application presentation interfaces, all undergirded by robust privacy and security protocols.

In the context of school governance, smart campuses provide educational leaders with critical operational data—such as utility consumption, facility utilization, and system engagement rates—allowing for highly efficient, data-driven resource optimization. Furthermore, intelligent centralized management systems enable a unified digital asset governance structure, promoting the seamless sharing of educational resources across distinct institutional departments or, in the case of multi-campus groups, across varied geographical locations [10]. The implementation of digital twin technology and predictive analytics within these environments can yield measurable benefits, such as significant reductions in energy consumption and improved academic retention through personalized learning hubs.

2.4. Distributed leadership in the era of accountability

The implementation of DDDM cannot be divorced from the organizational dynamics and cultural fabric of school leadership. The sheer complexity of modern educational governance, characterized by an influx of continuous data streams, requires a departure from solitary, top-down administrative models toward Distributed Leadership. Under distributed leadership, decision-making authority, analytical responsibilities, and accountability are shared among a broader network of stakeholders, including vice-principals, department heads, instructional coaches, and classroom teachers.

Effectively utilizing data requires building a pervasive "data-informed culture" where educators at all levels feel empowered, rather than surveilled or penalized, by analytical tools. When leaders co-construct distributed leadership frameworks centered on empirical data, they foster an ethos of continuous learning, collective accountability, and reflective professionalism. However, this transition requires profound shifts in organizational behavior, extensive professional development in data literacy, and the meticulous alignment of technological systems with the institution's core pedagogical values. Without careful management, distributed data systems can lead to initiative fatigue or the manipulation of metrics to serve localized political interests rather than student welfare.

3. Research methodology and context

To capture the profound intricacies of DDDM implementation within a living, highly complex educational ecosystem, this report employs a qualitative instrumental case study methodology.

3.1. Empirical context: T Primary School

The empirical setting for this analysis is T Primary School, an institution functioning as the vanguard within the broader R Primary School Education Group. The R Education Group, formally established in 2017, encompasses a comprehensive structural matrix of six primary schools and two kindergartens. The entire consortium operates under the philosophical banner of "Renhe" (people-oriented harmony) education, a doctrine that dictates a strict commitment to holistic student development, respectful and empathetic interpersonal dynamics, and a scientifically grounded approach to modernization.

3.2. Data sources and participant perspectives

The qualitative analysis draws upon documented institutional practices, administrative narratives, policy transitions, and critical incidents surrounding the implementation of DDDM at T Primary School. To ensure a holistic examination of the DDDM lifecycle—from executive mandate to classroom reality—the study analyzes the perspectives of varied stakeholders across the institutional hierarchy. The primary contributors to the institutional narrative are outlined in **Table 2**.

Table 2. The primary contributors to the institutional narrative

Participant identifier	Institutional role	Domain of implementation and perspective
Principal X	Executive School Leadership	The primary architect of the school's cultural and digital transformation. Provides macro-level insights into executive leadership, overcoming faculty resistance, and systemic organizational change.
Director L	Head, Teaching & Research	Oversees curricular design, elective platforms, and cognitive analytics. Provides insights into the operationalization of EDM for adaptive learning and intelligent tutoring.
Vice Principal Z	Head of Campus Informatization	Directs technical infrastructure and smart campus deployment. Reflects on the integration of centralized data management and formative evaluation systems.
Teacher W	Frontline Mathematics Educator	A relatively new educator offering critical perspectives on the ethical implications, privacy concerns, and socio-political frictions of distributed data governance.
Director D	Head, Information Teaching	Facilitator of computer science curricula. Provides critical incidents demonstrating the limitations of quantitative predictive data and the necessity of qualitative human intervention.

This multi-tiered perspective mitigates the risk of viewing technological implementation solely through an overly optimistic administrative lens, ensuring that the epistemological limitations and operational frictions of AI and big data in education are rigorously examined.

4. The genesis of transformation: Leadership and organizational culture

The transformation of T Primary School's administrative paradigm did not occur spontaneously; it was the result of a deliberate, meticulously phased orchestration of leadership philosophy, pedagogical innovation, and infrastructural enhancement. The integration of data into the school's governance was initially leveraged not as a technological upgrade, but as an instrument of cultural alignment.

4.1. Overcoming inertia through empirical consensus

Principal X proposed a strategic pivot toward the "Renhe" cultural identity, aiming to root the school's ethos in regional heritage and profound humanistic values. Initially, this top-down strategic vision faced significant skepticism and inertia from the mid-level management and general faculty. In a pivotal moment of leadership, rather than relying on executive fiat or hierarchical mandates, Principal X deployed a fundamental empirical tool: a school-wide survey asking all stakeholders to anonymously select their preferred ideal name for the institution. The aggregated data revealed an overwhelming consensus, with 97% of respondents favoring the historical "Renhe" designation due to deep-seated emotional and historical resonance.

This rudimentary but highly effective utilization of data marked the school's initial foray into DDDM. It demonstrated to the faculty that management decisions would be anchored in collective empirical evidence rather than solitary administrative intuition. This empirical consensus dissolved resistance and paved the way for the school's formal renaming and strategic realignment in 2008.

4.2. Institutionalizing the "Renhe" data culture

Following this initial success, Principal X institutionalized the "Renhe" management philosophy across three specific dimensions, intrinsically linking the school's humanistic organizational culture with the foundations of distributed data governance.

- Internalization: Embedding the core values of harmony and scientific inquiry into the cognitive frameworks of teachers and students through continuous dialogue, environmental design, and the creation of specific "Renhe" curricula. This ensured that when complex data systems were later introduced, they were viewed as tools to further the school's mission rather than alien impositions.
- Institutionalization: Translating cultural values into democratic administrative protocols. Frameworks such as the "Principal's Assistant System," regular "Teaching and Research Conferences," "Home-School Collaboration Committees," and transparent peer-evaluation voting systems were established. This architecture effectively distributed decision-making power across the network, creating the requisite structural pathways for distributed leadership in a data-rich environment. By involving teachers and students directly in the evaluation and planning processes, the school cultivated a profound sense of ownership.
- Emotional integration: Ensuring that data collection and performance metrics do not erode the school's humanistic fabric. Management maintains a strict focus on empathetic communication, ensuring that analytics are utilized to support, coach, and develop the faculty, rather than merely surveil or penalize them. As noted by the faculty, the leadership approach is designed to "move" and inspire educators, mitigating the algorithmic anxiety often associated with strict accountability metrics.

By intertwining data utilization with a highly empathetic, culturally resonant leadership model, Principal X established the psychological safety requisite for the school's subsequent, highly complex technological transformations.

5. Operationalizing EDM: Curriculum innovation and adaptive ecosystems

The most profound and technically sophisticated application of Educational Data Mining at T Primary School occurred within the Teaching and Research Department, under the direction of Director L. Responding directly to the national mandate for personalized education and the future-oriented themes of adaptive learning technologies, the department engineered a highly complex, data-responsive curricular ecosystem.

5.1. Predictive analytics in course selection

T Primary School developed the "Renhe Six Qualities" autonomous elective curriculum ecosystem, which encompasses six interconnected domains of holistic development. To support this, the school offers 85 distinct elective courses and has authored 17 proprietary textbook series, drastically increasing the complexity of resource allocation and scheduling.

To manage this complex matrix, the school developed a proprietary digital course selection platform that functions as a sophisticated predictive analytics engine. The data collection and feedback mechanism operates in a rigorous closed-loop cycle.

- Unconstrained preference mapping: During the initial selection phase, students scan into the system and are allowed to choose their preferred courses without any capacity constraints. This generates a pure, unconstrained dataset of baseline student interests across the entire student body.
- Pedagogical analytics and resource allocation: Administrators and researchers utilize this data to conduct comparative analyses. The statistical data revealed a strong systemic preference for highly participatory, experiential, and practice-oriented courses over traditional, passive linguistic subjects. This data directly informs Academic Analytics, guiding the administration on where to allocate funding, space, and teaching personnel.
- Iterative instructional design: The statistical preferences and the underlying reasons for those preferences are fed back to the educators. Teachers are tasked with investigating why certain pedagogical designs succeed or fail, adjusting their syllabi accordingly to incorporate more engaging, interactive elements. Following these data-informed adjustments, secondary satisfaction surveys indicated an 80% approval rating, demonstrating that even students who were eventually reallocated to their non-primary choices developed a strong affinity for the optimized courses.

This mechanism exemplifies an advanced DDDM system where data collection directly and continuously informs curriculum resource optimization, instructional refinement, and student satisfaction.

5.2. Cognitive science and micro-level learning analytics

Pushing the boundaries of EDM further toward the realm of intelligent tutoring systems, T Primary School is pioneering the integration of cognitive science and multimodal learning analytics. Director L's department initiated research programs to correlate the vast datasets of students' elective choices with physiological and cognitive metrics, utilizing specialized brain science evaluations to measure indices such as "working memory" and "cognitive ability." The correlation of these datasets allows the school to build highly precise predictive models regarding which pedagogical environments best suit specific cognitive profiles.

Going a step further into real-time analytics, the school experimented with computerized classroom observation systems. Utilizing tablet-mounted cameras during experimental classes, the system captures and analyzes students' facial micro-expressions. This biometric data generates continuous, time-series metrics on two primary axes: the "learning interest index" and the "attention index."

By overlaying these quantitative behavioral metrics with simultaneous classroom video recordings, educational researchers can pinpoint the exact pedagogical actions—such as specific phrasing, transitions, questioning techniques, or multimedia usage—that correlate with sudden spikes or drops in student engagement across the cohort. This transition from delayed summative assessment to real-time, micro-level instructional analytics represents a quantum leap in adaptive learning technologies. It provides empirical, irrefutable scaffolding for teacher professional development, allowing educators to deconstruct and refine their instructional strategies based on objective physiological responses rather than subjective observation.

6. Smart campus governance and formative evaluation

To support the immense data throughput, storage requirements, and cross-campus coordination required by these advanced EDM initiatives, Vice Principal Z spearheaded the deployment of a comprehensive Smart Campus infrastructure. Recognizing that siloed information is the primary impediment to effective institutional governance, the school prioritized centralized digital connectivity.

6.1. Centralized infrastructure and operational efficiency

The implementation of high-fidelity video conferencing systems drastically reduced administrative friction, travel time, and logistical overhead across the R Primary School Education Group's disparate campuses. This enabled seamless cross-campus academic research, training, and executive meetings. Furthermore, the deployment of centralized cloud storage servers established a unified repository for digital assets. Teachers and administrators, regardless of their physical location, can securely access, upload, and share authorized documents, multimedia resources, and administrative data, thereby realizing a truly interconnected smart campus ecosystem.

6.2. The Information Discipline Platform and continuous evaluation

A cornerstone of the smart campus initiative is the development of the "Information Discipline Platform," a specialized digital environment designed to operationalize continuous, formative evaluation. The platform fundamentally alters how academic progress is tracked and communicated, providing distinct, customized interfaces for different stakeholders.

- Student-facing interfaces: The platform provides students with personalized dashboards (e.g., "My Learning Plan") displaying dynamic scores, task completion rates, and comparative, gamified rankings such as the "Pinyin Typing Hero Board" and "Latest Excellence Rankings." This transparent data visualization gamifies the learning process, allowing students to accurately gauge their relative competencies, understand their knowledge gaps, and exercise self-regulated learning by setting customized goals based on their current metrics.
- Teacher-facing interfaces: For educators, the system acts as a powerful Learning Analytics dashboard. It visualizes the longitudinal learning trajectories of individual students, mining behavioral data to reveal underlying cognitive patterns. By identifying micro-level skill deficits and predicting potential learning bottlenecks before they manifest as failure, teachers can execute targeted, personalized interventions. This proactive approach ensures that instructional strategies are continuously adjusted to support true personalized learning, fulfilling the ultimate promise of data-driven education.

7. Strategic implications for artificial intelligence in education

The empirical evidence derived from the multifaceted implementation at T Primary School provides a highly fertile ground for extracting broader, second- and third-order insights applicable to the global discourse at the ISAIE 2026 conference. The transition from traditional governance to an integrated, AI-enhanced smart campus model is not merely a technological upgrade; it is a profound sociological and epistemological restructuring of the educational environment.

7.1. The imperative of "data-informed" over "data-driven" leadership

A recurring, dominant motif throughout this case study is the inherent danger of strict algorithmic determinism in educational settings. While "data-driven decision-making" remains the popularized academic and industry nomenclature, the operational reality at T Primary School dictates that successful, sustainable institutions must operate as "data-informed" environments.

Strictly data-driven approaches risk reducing the vibrant, chaotic, and deeply emotional reality of a K-12 classroom into sterile, easily manipulated variables. If school leaders rely exclusively on predictive analytics to govern curriculum flow or assess teacher performance, they risk embedding historical biases and systematically ignoring context. For example, a temporary drop in a student's "attention index" captured by a tablet camera might be algorithmically flagged by an EDM system as a behavioral deficit or a lack of engagement. However, a qualitative human assessment by an empathetic teacher might reveal the student is experiencing external emotional distress, or alternatively, is navigating a complex internal cognitive leap that simply does not manifest as typical visual engagement. Therefore, AI and EDM tools must be deployed strictly as augmentative instruments—tools designed to trigger human inquiry and pedagogical reflection—rather than autonomous agents that dictate definitive, unappealable administrative actions.

7.2. The role of educational large language models (LLMs) and adaptive technologies

Looking forward, the architectural models supporting smart campuses will need to evolve to address the qualitative gaps identified in this study. The current iteration at T Primary School—comprising centralized storage, video systems, and customized predictive learning platforms—represents a solid, functional foundational layer. Future iterations, highly responsive to the themes of ISAIE 2026, will likely incorporate Educational Large Language Models (LLMs) to synthesize both the quantitative metrics and the qualitative inputs.

For instance, the qualitative motivation gap experienced by Director D in the programming class could potentially be bridged by an LLM-driven intelligent tutoring system. Such a system could conduct natural language intake interviews with students prior to the course, analyzing their text responses to understand their intrinsic motivations, anxieties, and goals. The LLM could then interface with the EDM system to generate highly personalized, adaptive project pathways—such as immediately suggesting a "Smart Home" design track for a student who expresses interest in humanities rather than pure logic. By utilizing AI to process unstructured qualitative data at scale, schools can achieve mass personalization without losing the human narrative.

7.3. Reconciling distributed leadership with operational efficiency

The implementation of comprehensive data systems fundamentally alters the power dynamics of a school. By democratizing access to data, T Primary School successfully empowered teachers and students to participate actively in strategic governance. However, as Teacher W correctly identified, unfettered distributed leadership can inadvertently lead to bureaucratic paralysis, the avoidance of difficult academic decisions, or the prioritization of social consensus over objective educational quality.

To mitigate these risks, educational administrators must establish clear, heuristic boundaries for data usage and decision-making authority. Not all institutional decisions require, or benefit from, democratic consensus. A tiered, hybrid governance model is highly advisable. Under this model, macro-level strategic decisions (e.g., campus infrastructure investments, unified technology procurement, broad resource allocation) remain centralized and are driven primarily by rigorous Academic Analytics. Conversely, micro-level instructional decisions (e.g., localized curriculum pivots, individual student interventions, pedagogical styling) are distributed firmly to frontline educators who possess the necessary qualitative context and emotional intelligence to interpret Learning Analytics effectively. Furthermore, institutions must invest heavily and continuously in “data literacy” professional development, ensuring that teachers are not merely passive consumers of dashboard metrics, but critical interpreters capable of contextualizing statistical anomalies and challenging algorithmic outputs.

8. Conclusion

The exhaustive qualitative investigation into T Primary School’s operational evolution demonstrates unequivocally that the integration of big data, educational data mining, and artificial intelligence into educational governance is a highly complex, multidimensional endeavor that extends far beyond the mere procurement and installation of software systems. Driven by a strategic necessity to align with national digital modernization frameworks and optimize student learning outcomes, T Primary School successfully synthesized its indigenous, humanistic “Renhe” culture with advanced predictive platforms, adaptive learning technologies, and a unified smart campus infrastructure.

The empirical evidence from this case study confirms that data-informed leadership drastically enhances the precision of curriculum design, enables continuous and meaningful formative evaluation, and fosters a collaborative, distributed administrative ecosystem. However, the study also issues a critical, indispensable caveat to the field of educational technology: quantitative metrics and predictive algorithms are inherently devoid of human context. The severe apprehensions regarding collective bias, the potential erosion of privacy through continuous biometric monitoring, and the documented failure of quantitative data to accurately capture student motivation highlight the persistent, irreplaceable necessity of professional educator judgment.

As the global academic and technological community convenes at ISAIE 2026 to chart the future of Artificial Intelligence for Education, the lessons extracted from T Primary School provide a definitive, empirically grounded blueprint. The sustainable modernization of school management does not lie in the absolute surrender of strategic decision-making to autonomous algorithms. Rather, the future of educational governance lies in the deliberate cultivation of sophisticated socio-technical ecosystems—environments where robust data analytics and trustworthy AI provide the structural scaffolding, but empathetic, qualitative human insight firmly directs the architecture. Educational institutions that successfully navigate this delicate, continuous equilibrium will not only achieve unprecedented operational efficiency and academic personalization but will fundamentally elevate the standard of human flourishing in the rapidly advancing digital age.

Disclosure statement

The author declares no conflict of interest.

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