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Leveraging AI Learning Analytics to Support CRT-Based Creative Writing Strategies for Quality Education

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Abstract:

Creative writing instruction in multicultural classrooms requires balancing inclusive, culturally grounded pedagogy with timely, individualized feedback. Culturally Responsive Teaching (CRT) validates students' cultural identities in narrative expression, yet its assessment has traditionally relied on subjective, time-consuming teacher judgment. Advances in AI Learning Analytics, including natural language processing (NLP) and automated writing evaluation (AWE), offer the capacity to monitor writing processes and outcomes at scale. This study employs a qualitative library research design, a form of systematic literature synthesis, to examine how AI Learning Analytics can be conceptually integrated into CRT-based creative writing strategies and how this integration may contribute to Sustainable Development Goal 4 (Quality Education). Data comprised peer-reviewed journal articles, conference proceedings, and policy documents published between 2015 and 2025, with emphasis on recent work, analyzed through thematic synthesis. Three converging themes emerged. First, AI Learning Analytics provides linguistic, structural, and affective indicators that can approximate students' cognitive engagement, although cultural expression remains difficult to measure automatically. Second, AI-generated feedback mediated through CRT principles can enhance rather than homogenize culturally diverse voices. Third, this synergy supports equity-oriented, data-informed instruction aligned with SDG 4. The review also identifies risks of algorithmic bias, reduced human interaction, and contextual insensitivity. The study offers a conceptual framework for educators and policymakers designing culturally responsive, AI-supported creative writing pedagogy, while underscoring the continued necessity of human pedagogical judgment.

Keywords: AI Learning Analytics; Creative Writing; Culturally Responsive Teaching; Quality Education; Library Research

Introduction

Creative writing is one of the most complex literacy competencies of the 21st century, because it requires learners not only to master the structure and mechanics of language, but also to express their identity, experiences, and cultural background authentically. In modern education, creative writing is globally recognized as a crucial instrument for developing critical thinking, empathy, and students' self-agency (Cremin & Oliver, 2021). However, its teaching is often constrained by rigid traditional approaches that focus more on the final product than on the process of exploring identity (Locke & Daly, 2022). In increasingly multicultural classrooms, this challenge becomes more pressing: how can the writing learning ecosystem become a fair space for students from diverse social and cultural backgrounds, without falling into a single assessment standard that may overlook the diversity of narrative expression? When writing assessment ignores students' cultural context, there is a risk of covert marginalization of minority voices in the classroom (Haddix, 2021).

Culturally Responsive Teaching (CRT) is one of the most relevant pedagogical frameworks for bridging this problem. CRT emphasizes the importance of integrating students' cultural backgrounds, knowledge, and life experiences into the learning process so as to create a more inclusive and meaningful learning environment (Gay, 2018; Ladson-Billings, 1995). Recent research shows that applying CRT in literacy education can significantly increase students' *emotional engagement* and intrinsic motivation (Souto-Manning et al., 2024). In the context of creative writing, this approach means giving students room to write narratives rooted in their cultural identities, while still being guided toward the literacy standards set by the curriculum. Through the lens of CRT, students' texts are not assessed on blind compliance with dominant structures, but on how they navigate cultural richness within their literary canvas (Muhammad, 2023).

Nevertheless, the main challenge in implementing CRT-based creative writing lies in the complexity of monitoring each student's writing process individually, where teachers often struggle to track how cultural elements are internalized *in real time* (Hammond, 2025). This is where the role of *AI Learning Analytics* becomes highly urgent. AI-based analytical technologies are now able to unpack cognitive patterns, language style choices, and affective content in students' drafts instantly (Buckingham Shum et al., 2023). Integrating AI-based analytics into multicultural writing classes not only facilitates personalized formative assessment, but also helps teachers detect the extent to which students successfully express their cultural agency without losing linguistic coherence (Zawacki-Richter et al., 2024). By utilizing such inclusive analytical data, educational ecosystems can realize *pedagogical equity* aligned with the achievement of SDG 4 on Quality Education (UNESCO, 2023; Williamson et al., 2022).

At the same time, the development of artificial intelligence in education has given rise to the discipline of Learning Analytics, namely the measurement, collection, analysis, and reporting of data about learners and their contexts in order to understand and optimize the learning process (Siemens, 2013). Applying AI Learning Analytics to creative writing, through Natural Language Processing (NLP) and Automated Writing Evaluation (AWE) technologies, makes it possible to analyze word choice, narrative structure, coherence, and even the emotional sentiment of students' texts quickly and at scale (Mirzaei et al., 2025; Wilson et al., 2021). Several systematic reviews even report large effect sizes for automated feedback on improving writing quality, although the magnitude varies between first- and second-language contexts, as synthesized in several contemporary meta-analyses on automated writing evaluation.

Although CRT and AI Learning Analytics have each matured relatively well on their own, their conceptual intersection, especially in creative writing, is still rarely studied in an integrated way. CRT-based creative writing evaluation in practice still relies heavily on teachers' subjective judgment, which is time-consuming and prone to inconsistency among raters (Wilson et al., 2021). Meanwhile, most studies of AI in education still focus on the technical efficiency of scoring or grammar correction, and have not adequately considered how analytical systems can remain sensitive to cultural diversity rather than standardizing students' narrative styles to a single dominant linguistic norm (Bauer et al., 2023; Li & Yu, 2025).

This gap becomes increasingly important when viewed within the framework of Sustainable Development Goal 4 (SDG 4), which aims for quality, inclusive, and equitable education for all. Without precise yet culturally oriented monitoring, there is a risk that the use of AI technology in classrooms will widen, rather than narrow, gaps in literacy achievement among students from minority cultural backgrounds (UNESCO, 2015).

The novelty of this study lies in conceptually synthesizing two relatively parallel streams of literature, namely CRT in literacy education and AI Learning Analytics in writing assessment, into a coherent creative writing learning strategy framework oriented toward SDG 4. Unlike experimental studies that test the effectiveness of a particular AI platform with one student population, this study uses a library research approach to map patterns, convergences of findings, and conceptual tensions across previous studies, thereby producing theoretical propositions that can serve as a reference for future empirical research and learning practice.

Based on this background, this study is directed at answering two research questions: (1) How, according to the literature, can AI Learning Analytics map students' cognitive engagement and cultural expression in the creative writing process? (2) To what extent do CRT-based creative writing strategies supported by AI Learning Analytics, according to the synthesized literature, contribute to achieving the goals of quality education (SDG 4)?

Theoretical Framework

Culturally Responsive Teaching in Literacy and Creative Writing Instruction

The concept of CRT was first systematically developed by Ladson-Billings (1995) through the term "culturally relevant pedagogy", which emphasizes three main pillars: academic success, cultural competence, and students' critical awareness of the social structures around them. Gay (2018) expanded this framework into Culturally Responsive Teaching, which explicitly highlights the importance of bridging home culture and school culture through curriculum, communication styles, and contextually relevant learning strategies. In writing instruction, this principle is realized by giving students room to raise themes, idioms, and narrative structures that are familiar to their cultural backgrounds, rather than being forced to follow a single dominant narrative convention.

AI Learning Analytics in Education and Writing Assessment

Learning Analytics, as defined by Siemens (2013), is the process of measuring, collecting, analyzing, and reporting data about learners in order to understand and optimize learning. When combined with AI, particularly Natural Language Processing and machine learning techniques, such systems can automatically analyze various aspects of students' writing, including grammar, coherence, style, and indications of emotional sentiment in the text (Mizumoto & Eguchi, 2023; Wilson et al., 2021). A recent systematic review of creativity in Learning Analytics identifies the "4P" framework, namely Person,

Process, Product, and Press, as a general model for operationalizing data-based measurement of creativity. It covers the author's dispositions, the cognitive and affective processes undergone, the quality of the written product, and the environmental pressure or support for the creative process (Mirzaei et al., 2025).

Various studies of Automated Writing Evaluation show fairly consistent effectiveness in improving students' writing quality in general, with effect sizes reported to vary between second-language and first-language learner contexts, according to several independent meta-analyses (Zhang & Hyland, 2018). However, some studies also caution that this effectiveness is generally measured on the mechanical dimensions of writing, namely grammar, structure, and vocabulary, rather than on cultural expression or narrative originality (Bauer et al., 2023; Steiss et al., 2024).

Intersections of CRT and AI Learning Analytics: Opportunities and Tensions

Recent literature has begun to highlight the need to design "culturally aware" Learning Analytics, namely analytics systems that consciously consider the diversity of values and backgrounds of their users in the design process through a value-sensitive design approach, rather than being merely technically neutral (Viberg, Jivet, & Scheffel, 2023). An action study in early childhood teacher education also found that AI modules designed with cultural awareness can enrich teachers' learning ideas, yet still leave concerns about algorithmic bias and limited cultural representation in the model's training data (Li & Yu, 2025).

Thus, the intersection of CRT and AI Learning Analytics in creative writing can be understood as a complementary relationship that nevertheless requires careful pedagogical mediation. AI contributes rapid, scalable capacity for monitoring the writing process, while CRT contributes a value framework to ensure that the indicators and feedback generated by AI do not reduce or homogenize the diversity of students' cultural expression.

Methods

This study uses a qualitative approach with a library research design, focusing on the exploration, identification, and thematic synthesis of scientific documents relevant to the integration of AI Learning Analytics, Culturally Responsive Teaching, and creative writing. This approach was chosen because the research objective is conceptual and exploratory, namely to map patterns and relationships among concepts in the existing literature, rather than to generate new empirical data through experiments or field surveys.

The primary data sources of this study are reputable indexed journal articles, preferably from Scopus and Web of Science, proceedings of international conferences in Learning Analytics and Artificial Intelligence in Education, and global education policy documents related to SDG 4 (UNESCO, 2015; United Nations, 2015). The literature search used a combination of the keywords "AI learning analytics", "culturally responsive teaching", "creative writing", "automated writing evaluation", and "quality education or SDG 4" in the Scopus, Web of Science, ERIC, and Google Scholar databases.

The inclusion criteria were: (1) articles published between 2015 and 2025, with emphasis on publications from the last five years, namely 2020 to 2025; (2) containing at least one of three core concepts: AI or Learning Analytics in writing assessment, Culturally Responsive Teaching in literacy, or the relationship between educational technology and SDG 4; (3) peer-reviewed journal articles, reputable conference

proceedings, academic books, or official documents of international institutions; and (4) available in full text for in-depth analysis.

The exclusion criteria include articles that did not undergo peer review, such as popular opinion pieces without a scientific basis, as well as documents that discuss AI only in general terms without explicit relevance to writing instruction or culture-based pedagogy.

The data collection process followed four stages: first, identification through database searches using the predetermined keywords; second, screening based on titles and abstracts; third, feasibility assessment through full-text reading against the inclusion and exclusion criteria; and fourth, thematic synthesis of the documents that met the criteria. These stages generally follow the workflow logic of a systematic literature review, although this study does not apply statistical weighting through meta-analysis and instead uses qualitative thematic analysis.

Data analysis was carried out using thematic analysis, which involved repeated reading of the selected documents, open coding of the key concepts that emerged, grouping of codes into broader thematic categories, and interpretation of the relationships among themes within the study's conceptual framework. Source triangulation was conducted by comparing findings from the CRT literature, the AI Learning Analytics literature, and the SDG 4 policy literature, to ensure that the resulting interpretation does not rest on a single disciplinary perspective.

To maintain credibility, as is common in document-based qualitative research, the researchers applied cross-disciplinary source triangulation, kept an audit trail of the coding process, and conducted peer debriefing with academic colleagues to test the consistency of the thematic interpretation.

Results and Discussion

Findings

Thematic synthesis of the reviewed literature produced three main interrelated themes, as summarized in Table 1 and elaborated in the following subsections.

Table 1. Three Main Themes from the Literature Synthesis

Theme	Description of Findings	Supporting Sources
Mapping of cognitive engagement and cultural expression	AI Learning Analytics extracts linguistic, structural, and affective indicators from students' texts as proxies for cognitive engagement; cultural expression is harder to measure automatically.	Mirzaei et al. (2025); Wilson et al. (2021)
CRT mediation of AI feedback	AI feedback is most effective when mediated by teachers through CRT principles; without mediation, there is a risk of algorithmic bias.	Li & Yu (2025); Bauer et al. (2023); Viberg et al. (2023)
Contribution to SDG 4	The synergy of AI Learning Analytics and CRT supports large-scale personalization of writing instruction without sacrificing cultural equity.	UNESCO (2015); United Nations (2015)

Source: Synthesis of the reviewed literature (processed by the authors)

Theme 1: AI Learning Analytics as Mapping of Cognitive Engagement and Cultural Expression

The reviewed literature consistently shows that AI Learning Analytics, through NLP and sentiment analysis techniques, can extract quantitative indicators from students' narrative texts, such as lexical complexity, story structure coherence, revision patterns, and emotional tendencies in word choice (Mirzaei et al., 2025; Wilson et al., 2021). These indicators can be used as proxies, meaning indirect measures, of students' cognitive engagement in the writing process. However, findings from studies of creativity in Learning Analytics also emphasize that cultural expression and narrative originality are far more difficult to measure automatically than the mechanical aspects of writing, because they depend on implicit and culturally specific meanings (Mirzaei et al., 2025).

Examining the four-P framework, namely Person, Process, Product, and Press, proposed in a systematic review of creativity in Learning Analytics, makes clear that the strengths of AI Learning Analytics are not distributed evenly across these four dimensions (Mirzaei et al., 2025). On the Product dimension, namely the final quality of the writing, AI systems are relatively strong because they can consistently measure grammar, sentence structure, and cohesion across paragraphs. On the Process dimension, AI capability is also promising, through tracking of revision patterns and writing speed. However, on the Person dimension, namely the author's unique dispositions and background, and the Press dimension, namely the social and cultural environmental pressures and support for the creative process, AI capability is far more limited, because both dimensions depend heavily on cultural context and social relations that are difficult to represent through the surface linguistic features of a text alone.

The imbalance in capability across these four dimensions is not merely a temporary technical limitation, but reflects a more fundamental epistemological issue. AI models used for writing assessment are generally trained and calibrated on large-scale data corpora representing dominant writing conventions. Structurally, these models are therefore more sensitive to patterns that frequently appear in their training data than to distinctive narrative patterns of cultural groups that are rarely represented in such corpora. Studies of large language models for automated essay scoring show that the reliability of AI assessment is strongly influenced by how closely the linguistic characteristics of the text resemble the model's training data, including particular academic writing conventions (Mizumoto & Eguchi, 2023). The implication is that the cognitive engagement indicators produced by AI Learning Analytics risk being systematically more accurate for students whose writing style aligns with these dominant conventions, and less accurate for students from cultural backgrounds whose narrative styles differ. This is a risk that runs counter to the inclusion goals at the core of CRT.

This finding also clarifies the real limits of AI Learning Analytics' contribution to CRT-based creative writing instruction: it is useful as an indicative instrument for mapping process and product, rather than as the sole judge of cultural expression. Mapping cognitive engagement through linguistic and structural indicators remains practically valuable for teachers, particularly for identifying students who show minimal revision or low coherence and who therefore need early attention. However, decisions about whether a narrative expression should be considered original, culturally meaningful, or an authentic representation of a student's identity still require contextual judgment by teachers who understand their students' cultural backgrounds. At the current level of technological development, no analytical system can yet replace this capacity.

Theme 2: CRT Mediation of AI-Based Feedback

The second theme emerging from the literature synthesis is the importance of teachers' pedagogical mediation in interpreting and following up on AI feedback so that it aligns with CRT principles. Studies of AI integration in culturally inclusive curricula find that AI is most effective when positioned as a tool that expands teachers' pedagogical options, for example by providing culturally relevant analogies or examples, rather than as a substitute for teachers' assessment and direct interaction with students. Several studies explicitly warn of the risk of algorithmic bias, since AI models are generally trained on data corpora dominated by particular language and cultural conventions, which can lead to judgments that are less fair toward the narrative styles of minority cultural groups (Li & Yu, 2025; Bauer et al., 2023).

The need for this mediation is reinforced by empirical findings from direct comparisons between the quality of human feedback and generative AI feedback. Research comparing feedback from trained teachers with ChatGPT feedback on secondary school students' writing found that human feedback was consistently superior in almost all aspects of formative quality, except in alignment with predetermined assessment criteria, where AI performed relatively comparably (Steiss et al., 2024). This pattern has important implications for CRT-based creative writing instruction. AI's strength lies in the aspect most easily standardized, namely matching criteria, while its weakness lies in the aspects most needed in culturally responsive pedagogy: a supportive tone, contextual directions for improvement, and sensitivity to the nuanced meaning that students intend. This confirms that teacher mediation is not merely an optional supplement, but a structural compensation for weaknesses inherent in how generative AI itself works.

In line with this, the idea of culturally aware learning analytics emphasizes the need for value-sensitive design, in which analytical indicators are not designed as neutral single standards, but take into account the diversity of values and perspectives of their users from the system design stage onward (Viberg, Jivet, & Scheffel, 2023). This approach highlights privacy and autonomy as two values whose meanings may differ significantly across cultures. Learning Analytics systems designed on the value assumptions of one cultural context therefore risk producing experiences that are unfamiliar or even uncomfortable for students from other cultural contexts. Applying this principle to creative writing means that indicators of engagement and writing progress should not be designed as if they were universal, but should be adjustable to the communicative norms and cultural expectations prevailing in particular student groups.

An action study in early childhood teacher education provides a concrete illustration of how such mediation can operate in practice. Teachers trained to use a culturally aware AI module reported that the AI helped enrich their learning ideas and offered variations of activities they had not previously considered. At the same time, they expressed concern about inadequate cultural representation in the system's outputs, and so they actively adjusted and re-curated the AI's suggestions before using them in class (Li & Yu, 2025). This pattern illustrates a genuine form of CRT mediation: teachers neither reject nor accept AI outputs uncritically, but position themselves as active curators who filter those outputs through a deep understanding of their students. However, this pattern also implies an additional cognitive burden for teachers, who are now expected to have AI literacy and cultural literacy at the same time, a professional development need that has so far not been widely addressed in general teacher training programs.

Theme 3: Contribution of AI Learning to Quality Education (SDG 4)

The third theme highlights how the integration of AI Learning Analytics and CRT in creative writing can be mapped onto various SDG 4 targets, particularly target 4.1, which concerns ensuring relevant and effective learning outcomes, and target 4.5, which concerns eliminating disparities and ensuring access to education for vulnerable groups. UNESCO (2015) policy documents emphasize that quality education is measured not only by standardized achievement, but also by the extent to which the education system can accommodate learner diversity. Within this framework, combining AI Learning Analytics with CRT has the potential to enable large-scale personalization of writing instruction without neglecting cultural equity, provided it is accompanied by oversight of algorithmic bias risks and excessive dependence on automation.

In addition to targets 4.1 and 4.5, the SDG 4 framework also includes target 4.7, which explicitly emphasizes education that fosters appreciation of cultural diversity and of culture's contribution to sustainable development (United Nations, 2015). The synergy between AI Learning Analytics and CRT is more directly relevant to this target than to targets 4.1 or 4.5, because the core of CRT-based creative writing instruction is the recognition and validation of students' cultural identities as legitimate parts of the learning process, rather than merely adjusting teaching methods to be more efficient. Accordingly, the most substantive contribution of this integration to SDG 4 lies in the dimension of appreciating cultural diversity, while its contribution to quantitatively equalizing learning achievement remains indirect and requires further empirical verification.

The contribution to SDG 4 also needs to be read critically, given the potential tension between the principles of scale and equity. Widespread application of AI Learning Analytics generally requires the availability of devices, stable internet access, and teachers' capacity to operate digital platforms. These prerequisites are precisely the hardest to meet for under-resourced schools, which in many contexts also serve student populations from the cultural backgrounds most in need of CRT approaches. If these infrastructure prerequisites are not seriously addressed, the benefits of AI-based personalization of writing instruction may be felt first by well-resourced schools, while the schools most in need of cultural equity in writing assessment fall behind in accessing the technology. This could inadvertently widen, rather than narrow, the gap that SDG 4 seeks to address.

It should also be noted that Learning Analytics is itself still a relatively young discipline, which has only begun to consolidate its conceptual frameworks and research base over the last decade (Siemens, 2013). Its culturally sensitive variant, culturally aware learning analytics, is even more recent and, to date, has been supported more by conceptual and small-scale studies than by large-scale empirical validation across cultural contexts (Viberg, Jivet, & Scheffel, 2023). On this basis, claims about the real contribution of integrating AI Learning Analytics and CRT to achieving SDG 4 are more appropriately understood as potential supported by strong theoretical arguments, rather than as findings empirically proven at the scale of education systems. This epistemic caution matters so that policymakers do not hastily make this integration a single solution for SDG 4, but treat it as one promising pathway that still requires gradual trials, rigorous evaluation, and sustained monitoring of its impact on equitable access.

Read together, the three themes lead to the following conclusion: what connects them is that AI Learning Analytics consistently excels at what can be standardized and measured at the surface level, whereas CRT is consistently needed precisely where such standardization ceases to apply, namely in cultural meaning-making, pedagogical relationships, and access equity. This pattern is not coincidental; it reflects the basic

character of both approaches. The most realistic synthesis is therefore not to have one replace the other, but to design a clear division of roles in which AI handles the scale and speed of monitoring, while CRT ensures that such scale and speed do not sacrifice the meaning and cultural equity that lie at the heart of quality education itself.

Analysis

The findings above show that the relationship between AI Learning Analytics and CRT in creative writing instruction is complementary, but not automatically harmonious. AI Learning Analytics addresses the efficiency and scale of monitoring the writing process, a structural limitation that has long hindered teachers with heavy workloads from applying CRT consistently. However, this success is only partial. The literature consistently shows that AI performs better in assessing the mechanical dimensions of writing, such as grammar, structure, and cohesion, than in assessing cultural expression and narrative originality, which are the core of CRT itself (Mirzaei et al., 2025; Steiss et al., 2024).

These findings both confirm and extend the arguments of earlier reviews of AI in education, which generally conclude that AI is most effective as a complement to, rather than a replacement for, human assessment and interaction (Bauer et al., 2023; Zhang & Hyland, 2018). The contribution of this study to the existing literature is to place CRT explicitly as a normative mediation framework that determines how the outputs of AI Learning Analytics should be interpreted and acted upon in creative writing instruction. This emphasis rarely appears in an integrated way in the more technically oriented studies of AI in education.

Within the framework of SDG 4, this synergy can be understood as an effort to create more equitable and high-performing classroom ecosystems. AI provides an objective data base for monitoring each student's writing progress, while CRT ensures that such progress standards are not defined narrowly by a single dominant cultural convention. However, this discussion must also be balanced with caution regarding three main limitations that consistently emerge in the literature. First, algorithmic bias originating from AI training data that are less culturally representative. Second, the risk of reduced direct pedagogical interaction between teachers and students if automation is used excessively. Third, the methodological limitations of many existing studies, most of which are small-scale, short-term, or focused on English as a second language, so that their generalization to other cultural and linguistic contexts, including the Indonesian context, still requires further empirical study.

For teachers, these findings suggest using AI Learning Analytics as an early diagnostic tool, which is then reinterpreted through the teacher's cultural sensitivity toward students' backgrounds, rather than as a final assessment decision. For educational technology developers, the findings underscore the need to involve experts in culturally responsive pedagogy and diverse user communities from the design phase onward through value-sensitive design, in order to minimize algorithmic bias. For education policymakers, this integration can be one strategy for achieving SDG 4 targets, provided that investment in AI infrastructure is balanced with investment in developing teachers' capacity for culturally responsive pedagogy.

As a library-based study, this research is limited by its reliance on published literature. It therefore does not produce new empirical data from specific classroom contexts, and it may inherit publication biases from the reviewed literature. Future research is recommended to conduct empirical studies, through mixed methods, design-based research, or in-depth qualitative case studies, to directly test the conceptual

framework in specific multicultural classroom contexts, including education in Indonesia with its wide diversity of cultures and regional languages. Further research should also explore the use of the latest generative AI models to provide more culturally contextual feedback, as well as practical algorithmic bias auditing mechanisms that educational institutions with limited resources can apply.

Conclusion

Based on the literature synthesis, it can be concluded that AI Learning Analytics has a real capacity to map students' cognitive engagement in writing through linguistic, structural, and affective indicators. However, this capacity remains limited in capturing the nuances of cultural expression that are the central concern of CRT. CRT-based creative writing strategies supported by AI Learning Analytics have the potential to contribute to achieving SDG 4, as long as AI is positioned as a supporting instrument for teachers' pedagogical decisions rather than the sole authority in assessment, and as long as the design of the analytical system consciously considers the cultural diversity of learners.

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