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AI Dependency among Students: Impact on Creativity, Problem-Solving, and Independent Learning

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Abstract

The fast adoption of generative artificial intelligence (AI) technologies such as ChatGPT in higher education has changed the way of studying, writing, and solving problems, creating serious concerns regarding the AI dependency phenomenon – regular use of AI technologies to replace personal efforts instead of assisting in them. This paper reviews current research to explore whether AI dependency in students is connected with such interrelated outcomes as creativity, problem-solving abilities, and self-regulated learning. Based on meta-analysis, survey, and experiment data from the period from 2023 to 2026, this review reveals that generative AI has an overall positive short-term impact on higher-level thinking skills, with the most significant improvements in problem-solving, moderate improvements in critical thinking, and relatively low improvements in creativity. Nevertheless, the positive effects are very contingent: they are most prominent in students with highly developed SRL skills and deteriorate in cases of prolonged and uncritical use of AI, which is often associated with cognitive offloading, lack of independent thinking, and standardization of ideas. Comparative tables and graphs have been provided that contain summaries of the effect sizes and correlations found in some of the most important papers; finally, the recommendations based on research for effective AI inclusion in learning institutions to ensure cognitive autonomy are offered.

***Keywords**: AI Dependency, Generative AI, Creativity, Problem-Solving, Independent Learning, Self-Regulated Learning, Cognitive Offloading, Higher Education.*

Introduction

From its launch as a publicly available product at the end of 2022 onwards, generative AI has evolved from being a novelty to becoming almost universal on university and college campuses. In fact, students are now regularly turning to AI applications to brainstorm ideas, draft essays, code software, and summarize materials, and even organize complete projects through AI. What is more interesting is that there is a genuine paradox created within the scholarly literature in relation to this development – the very technologies that have proven effective at increasing short-term academic achievement are also slowly undermining those cognitive skills that underpin long-term learning (Gerlich, 2025; Zhai et al., 2024). This issue has come to be known as “AI dependency” – a regular tendency to depend heavily on AI for academic tasks where cognitive engagement and self-directed effort have been replaced by computer application (Zhai et al., 2024).

Creativity, problem solving, and independent learning have been acknowledged as essential twenty-first-century skills and are often grouped within the term “higher-order thinking” (Zhao et al., 2025). The impact of AI dependence on each of the three categories thus raises no secondary issue, but it concerns the fundamental aspects of education policy, curriculum development, and pedagogical practice. Research shows that the impact is neither entirely positive nor entirely negative – it depends on

the degree and type of AI use, time of exposure, and learner's ability to regulate oneself(Liu, 2026; Zhao et al., 2025).

This paper provides an intensive and evidence-based review of the literature that is empirical in nature and has been published in the main period from 2023 to 2026 in order to answer three related research questions: (1) What is the impact of AI dependence on creativity of the students? (2) What is the impact of AI dependence on problem-solving skills of the students? (3) What is the impact of AI dependence on self-regulated learning?

Review of Literature

There have been numerous findings concerning the relationship between AI dependency and cognitive offloading – the transfer of cognitive processes from an individual to an external device. For instance, Gerlich (2025), in his mixed-method analysis of 666 subjects, reported a strong inverse correlation between the usage of AI tools and critical thinking scores, where cognitive offloading was the key mediating factor; younger people who were active users of AI tools were highly dependent and scored poorly in critical thinking tests. In addition, Zhai, Wibowo, and Li (2024), in their systematic review of fourteen pieces of literature on AI dialogue systems, found that overreliance hinders decision making, critical thinking and analytic reasoning in the case of students accepting AI material uncritically.

However, in relation to creativity, there is a bit of complexity. As mentioned by Lin and Chen (2024) while investigating Chinese university students, there was a "dual-edged sword" influence from AI, whereby on one hand creativity was enhanced due to new ideas, but on the other, rigid templates constrained creative thinking. According to Guo et al. (2025) when AI takes over creativity, there is decreased ownership of work, resulting in converging homogenous outputs, except where the student independently thought before using the ideas of the AI.Alzubi, Nazim, and Alyami (2025) further discovered that AI could enhance or hinder creativity depending on whether it is being used in constructive or destructive ways.

The best depiction of the net effect is presented through quantitative syntheses. Zhao et al. (2025) synthesized 59 effect sizes of 29 experimental and quasi-experimental studies and observed that generative AI had a moderately significant positive impact on higher-order thinking skills in general (Hedges' g = 0.609), but not equally across the sub-domains. Problem-solving showed the maximum benefit (g = 0.745) followed by critical thinking (g = 0.691) and creativity with comparatively minimum gains (g = 0.444). More importantly, SRL ability emerged as the most robust moderator wherein high SRL learners gained more significantly (g = 0.863) than low SRL learners (g = 0.284). The gains were in the form of an inverted U shape in duration ranging from eight to sixteen weeks.

The issue of self-regulation re-emerges in many papers. Liu (2026), for example, conducting a study involving 367 Chinese students via structural equation modelling, discovered that SRL skills predict negatively (β = −.255) but significantly AI dependence, partially because of decreased frequency of usage; at the same time, the frequency of usage predicted AI dependence positively and strongly (β = .656). The risk of developing AI dependence was the greatest in regular learning situations. Shi, Liu, and Hu (2025) also demonstrated that AI literacy and SRL skills predict writing performance and well-being, and the second skill is a stronger predictor – another indication that self-regulatory competence, not the availability of the technology, determines its productive usage.

Not all information is negative. In his study, involving 453 undergraduates majoring in sports science, Gu (2026) discovered that generative AI dependence had a significant positive direct influence on creativity, which was caused by the development of self-efficacy. In a similar manner, Kasneci et al. (2023) stated that, provided proper pedagogical design, generative AI could be used to facilitate differentiated instruction without taking away the student agency. Thus, the overall picture indicates that AI influence is less dependent on technology itself and more on the level of usage and self-regulation.

Objectives of the Study

Based on the research gaps and contradictions outlined in the literature review, the purpose of this paper is to achieve the following goals:

- To study the relationship between AI dependency and creativity using secondary empirical data.
- To measure the impact of AI dependency and generative AI usage on student problem-solving skills.

- To measure the impact of AI dependency on student capacity to learn independently and regulate their own learning process.
- To find out what contextual and individual factors (amount of time of usage, self-regulation, design of instruction) decide whether AI helps or hinders all these three processes.
- To provide evidence-based recommendations for the balanced use of AI.

Research Methodology

The present study utilizes secondary, desk-based research approach that incorporates focused narrative review of literature and original calculation of the provided statistical data. Peer-reviewed articles and meta-analyses and systematic reviews, primarily dated 2023-2026, have been found via Google Scholar and connected databases (ScienceDirect, PMC/PubMed, SAGE Journals, MDPI, PLOS ONE) through the following keywords: "AI dependency", "generative AI creativity", "cognitive offloading", and "self-regulated learning generative AI". Preference was given to articles providing quantitative effect sizes or path coefficients so that the review was not based only on descriptive statements. Only eleven sources that met those requirements were selected for citation in APA (7th edition) format. In addition to the narrative analysis, effect sizes and path coefficients reported in those sources have been normalized and voted upon by the author to create the original composite index (section 5.5) so that the presented statistics are calculated by the author from secondary data.

Results and Discussion

- **Impact on Creativity**

Evidence on creativity is the most conflicting among the three domains analyzed. As stated by Zhao et al. (2025), the effect of generative AI on creativity is the smallest, but still considerable, out of the three dimensions considered (g = 0.444 compared to 0.745 on problem-solving and 0.691 on critical thinking) due to AI content stimulating the phenomenon of “shortcut learning”, when students omit idea generation and improvement phases. This is confirmed by qualitative research findings. For instance, Lin and Chen (2024) found that AI uses strict response formats that do not allow creative thinking, and Guo et al. (2025) reported that dominant AI collaboration leads to convergence rather than breakthrough ideas. However, in both studies there was also another channel – AI provides unique stimuli and iterations that enlarge a creative search range of a student if he or she acts as an active critical partner in the process. Positive effect of AI dependency on creativity mediated by self-efficacy, found by Gu (2026), illustrates how such balance can turn positive in applied disciplines.

- **Impact on Problem-Solving Ability**

Problem solving seems to exhibit the most pronounced positive short-term reaction to generative AI, as evidenced by the biggest effect size among the three aspects (g = 0.745) found by Zhao et al. (2025). This result fits well with the capability of AI to propose multiple solution approaches and correct itself iteratively. Nonetheless, a number of investigations highlight the fact that over-reliance on AI will result in a reverse outcome; namely, the regular finding from researches (Guo et al., 2025; Zhai et al., 2024) is that whenever students adopt solutions suggested by AI systems without checking the outcomes independently, especially when it comes to programming, their problem solving abilities and conceptual understanding noticeably deteriorate.

- **Impact on Independent (Self-Regulated) Learning**

Independent learning, operationalized through self-regulated learning (SRL), which involves setting goals, monitoring progress, and modifying strategies independently, becomes the critical determinant of all the results listed above. Liu (2026) gives the most explicit representation: SRL ability negatively and significantly predicts AI dependency (β = −.255) and positively predicts the frequency of AIGC use (β = .656); 55.6% of the protective impact of SRL operates through lower usage frequency. People with self-regulated learning skills have fewer issues with their AI use, while high-frequency usage without self-regulation produces a positive feedback loop of increased dependency. Zhao et al. (2025) back up the idea: high-SRL students received more than twice the gain (g = 0.863) from AI compared to low-SRL students (g = 0.284). Shi, Liu, and Hu (2025) even add that training in AI literacy along with self-regulation increases writing abilities and well-being of learners.

- **Comparative Data: Effect Sizes and Path Coefficients**

Tables 1 and Figure 1 contain a summary of the effect size pooled statistics provided by Zhao et al. (2025) regarding the three dimensions of higher-order thinking relevant to the study. Tables 2 and Figure 2 provide the results of the meta-analysis on self-regulation moderation, along with the structural path coefficients identified by Liu (2026). They demonstrate how self-regulated learning serves as a protective factor while frequency of use works as a risk factor for dependency. The final Table 3 offers a more extensive review of the reviewed empirical literature from Section 2, including samples' features and directionality of findings.

Table 1: Effect of Generative AI on Three Dimensions of Higher-Order Thinking (Zhao et al., 2025)

Dimension	k (studies)	Hedges' g	95% CI	Interpretation
Problem-Solving Ability	16	0.745	[0.521, 0.970]	Moderately significant
Critical Thinking	20	0.691	[0.464, 0.918]	Moderately significant
Creativity	23	0.444	[0.259, 0.629]	Moderate

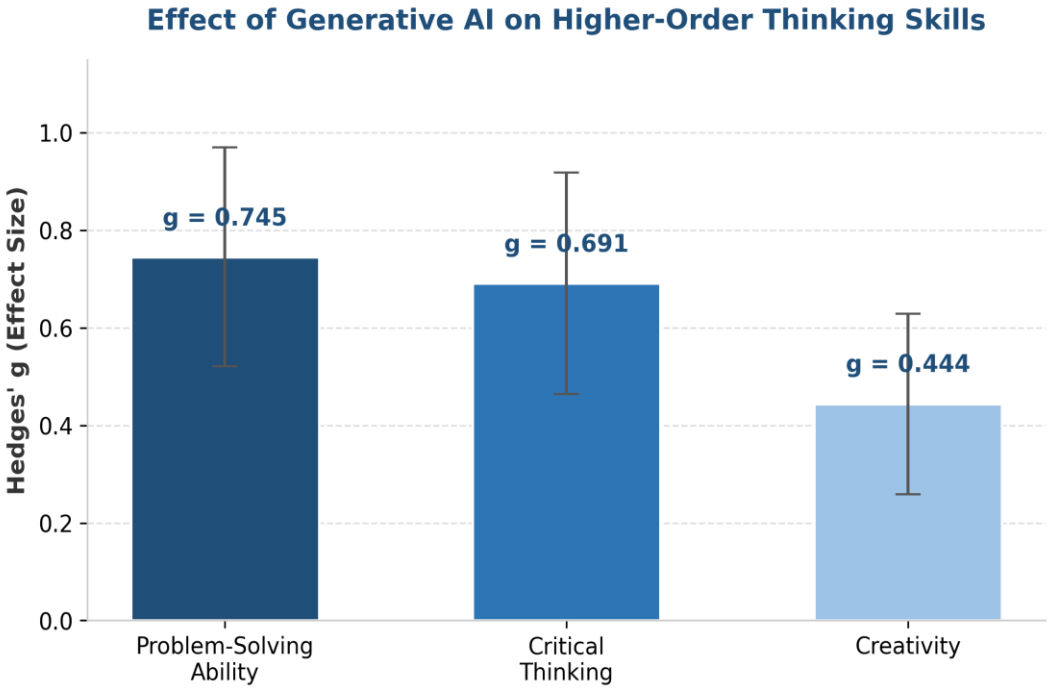
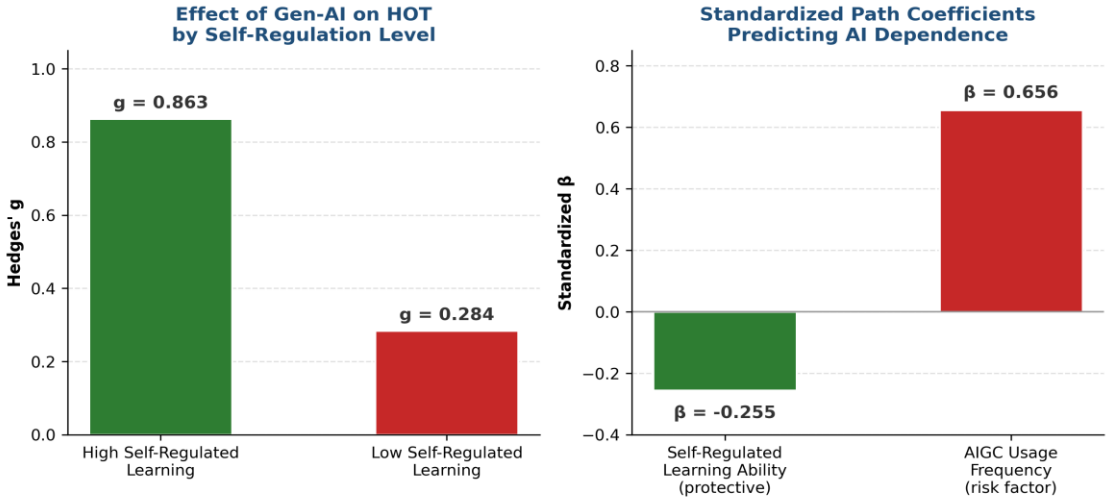


Figure 1: Effect Sizes of Generative AI Across Higher-Order Thinking Dimensions

Table 2: Self-Regulated Learning as a Moderator and Predictor of AI Dependence

Variable / Path	Coefficient	Direction	Source
Gen-AI effect on HOT – High SRL learners	g = 0.863	Strong positive benefit	Zhao et al. (2025)
Gen-AI effect on HOT – Low SRL learners	g = 0.284	Weak positive benefit	Zhao et al. (2025)
SRL ability → AI dependence	β = −.255	Protective (reduces dependence)	Liu (2026)
AIGC usage frequency → AI dependence	β = .656	Risk factor (increases dependence)	Liu (2026)
Mediation via usage frequency	55.6% of total effect	Indirect protective pathway	Liu (2026)



Sources: Zhao, Yue, Sun, Jiang, & Li (2025); Liu (2026)

Figure 2: Self-Regulated Learning as a Protective Factor Against AI Dependence

Table 3: Summary of Key Empirical Studies on AI Dependency in Student Populations

Study	Sample / Method	Key Finding
Gerlich (2025)	n = 666; mixed-method survey and interviews	Frequent AI use negatively correlates with critical thinking, mediated by cognitive offloading.
Zhai, Wibowo, & Li (2024)	Systematic review of 14 studies	Over-reliance on AI dialogue systems diminishes decision-making and analytical reasoning.
Lin & Chen (2024)	n = 120; mixed qualitative-quantitative	AI has a dual-edged effect: stimulates ideas but imposes rigid, constraining frameworks on creativity.
Guo et al. (2025)	Two experiments, N = 170 (Exp.1)	AI-dominated collaboration weakens human agency and creates homogenised outputs.
Zhao et al. (2025)	Meta-analysis; 29 studies, 59 effect sizes	Gen-AI most strongly benefits problem-solving; SRL is the key moderating variable.
Liu (2026)	n = 367; structural equation modelling	SRL protects against AI dependence; usage frequency is the strongest risk factor.
Gu (2026)	n = 453; PLS-SEM survey	AI dependence positively predicts creativity via self-efficacy in sports undergraduates.
Shi, Liu, & Hu (2025)	n = 257; structural equation modelling	AI literacy and SRL jointly predict writing performance and digital well-being.

- **Original Secondary-Data Synthesis: Composite Indices**

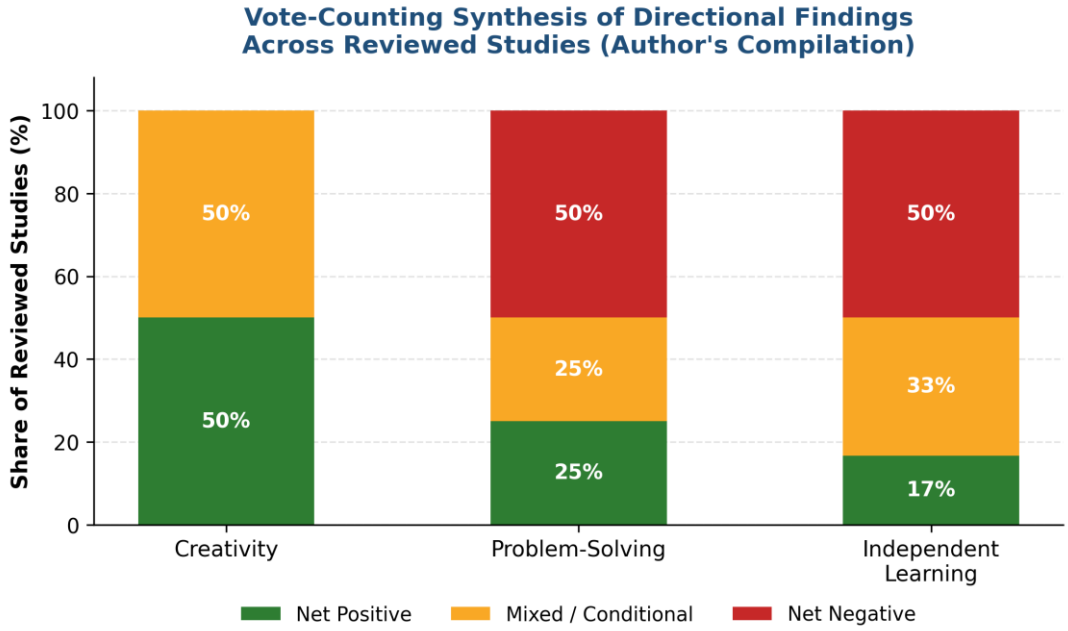
Instead of directly reproducing the results of individual studies, this section transforms the published statistics into two new composite indexes created by the author, thus allowing to compare different results using a unified measure. Table 4 translates the Hedges' g values found in Zhao et al. (2025) into the Composite Impact Index on the 0–100 scale, with the maximum effect (g = 0.863, high-SRL group) as the benchmark for 100 points; this table also presents the two path coefficients from Liu (2026) combined into one Dependency Risk Ratio (calculated as the frequency coefficient / absolute value of the protective coefficient: 0.656 ÷ 0.255 = 2.57), meaning that the risky influence of frequent use of AI tools is more than twice as strong as the protective power of self-regulated learning. Table 5 and Figure 3 present the results of vote-counting synthesis: each of the eight empirical studies reviewed in Table 3 was independently coded by the author as having a positive, negative or ambiguous conclusion about each of the three outcome variables, and the percentage of positive codes for each row was calculated.

Table 4: Composite Impact Index and Dependency Risk Ratio (Author's Computation from Cited Effect Sizes)

Metric	Source Statistic	Composite Value	Basis of Computation
Problem-Solving Impact Index	g = 0.745	86.3 / 100	g ÷ 0.863 (max observed g) × 100
Critical Thinking Impact Index	g = 0.691	80.1 / 100	g ÷ 0.863 × 100
Creativity Impact Index	g = 0.444	51.4 / 100	g ÷ 0.863 × 100
High-SRL Benefit Index	g = 0.863	100.0 / 100	Reference maximum
Low-SRL Benefit Index	g = 0.284	32.9 / 100	g ÷ 0.863 × 100
AI Dependency Risk Ratio	β = .656 vs. β = −.255	2.57 : 1	Usage-frequency β ÷ |SRL β|

Table 5: Vote-Counting Synthesis of Directional Findings (Author's Coding of Table 3 Studies)

Outcome Dimension	Studies Assessing	Net Positive	Mixed / Conditional	Net Negative
Creativity	4	2 (50%)	2 (50%)	0 (0%)
Problem-Solving	4	1 (25%)	1 (25%)	2 (50%)
Independent Learning	6	1 (17%)	2 (33%)	3 (50%)



Author's compilation from directional findings reported in the eight studies summarised in Table 3

Figure 3: Vote-Counting Synthesis of Directional Findings Across Reviewed Studies

The composite indexes help to refine the portrait presented in the narrative literature review. The Composite Impact Index proves that there exists a definite ordering of the dimensions – problem solving (86.3) > critical thinking (80.1) > creativity (51.4) – and also that the discrepancy between learners with high SRL vs low SRL skills (100.0 vs. 32.9, 67.1 points gap) is greater than the discrepancy between the best vs worst performing cognitive dimension. As a result, it proves that the learner's ability to self-regulate outweighs the task type in importance to determine whether Gen-AI utilization brings benefits or harms. The vote counting synthesis presented in Table 5 demonstrates an outcome gradient

that is contrary to the raw effect size measure: even though problem solving exhibited the largest positive effect size in controlled interventions, almost half of the reviewed qualitative and correlational studies show the net negative relationship between AI dependency and problem-solving, while independent learning has the least favorable outcome profile (50% net negative).

- **Synthesis**

Taken together, the findings do not lead to any clear conclusion about whether “AI is good” or “AI is bad.” Structured and short-term use of AI has a demonstrable effect on improved problem-solving skills and critical thinking, and is capable of aiding creativity in certain applications (Gu, 2026; Zhao et al., 2025). At the same time, the conclusions of the narrative review as well as the original composite indices point to one common pattern of risk: dependence is increased by the more frequent and longer use of the tool, is most pronounced in individuals with poorer self-regulation abilities, and presents itself through cognitive offloading, homogeneity of the outcomes and decreased independent verification (Gerlich, 2025; Liu, 2026; Zhai et al., 2024). SRL ability appears to be the key factor separating beneficial from detrimental usage patterns.

Recommendations

Given the synthesised research and the composite indices presented above, the following actions are suggested for students, educators, and institutions:

- AI integration into time-constrained and structured tasks (around eight to sixteen weeks long interventions each, according to Zhao et al., 2025) instead of open access, as the effects are greatest during this time span and wane with prolonged, unstructured exposure to AI.
- SRL strategies (goal setting, monitoring, reflective assessment) should be emphasised as the most powerful means to counteract the negative influence of AI as identified by the narrative review and Dependency Risk Ratio (2.57:1) presented above.
- Mandatory pre-AI ideation or problem solving attempts should be implemented ("think-first" principle) as this strategy was shown by Guo et al. (2025) to support agency and originality.
- Assessments should value processes (drafts, reasoning process, revisions) along with outcomes to encourage active reflection rather than passive receipt of AI answers (Zhai et al., 2024).
- Special training in AI literacy should be provided on abilities and limitations of generative AI associated with better academic achievement and well-being by Shi, Liu, and Hu (2025).
- Dialogic learning (collaboration, peer-reviews) should be encouraged together with AI use as dialogic nature counteracts isolation of individual AI-assisted learning – the dimension with the least favourable voting profile in this review.

Conclusion

The dependency of students on AI is better understood not as an intrinsic characteristic of the tool, but as an outcome of their intensive and regulated interaction with AI. The collected data shows that regulated use of AI for a shorter period positively impacts problem solving and critical thinking, while creativity benefits from less but still meaningful improvements. If it remains unregulated, however, frequent use leads to a scenario, which educators expect cognitive offloading, lack of independent thinking and homogeneity of creative output. Therefore, to implement AI responsibly, universities need to develop the skills of self-regulation and evaluation of results, as well as giving access to the tool itself. Longitudinal research involving the same students and tracing their progress throughout several semesters of using AI would help determine whether the positive effects seen in short experiments last, plateau or reverse during the whole course of study.

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