

# AI as a Cognitive Shortcut: Examining the Relationship Between AI Dependency, Students' Understanding, and Critical Thinking in Higher Education

Suha Al-Dulaimi<sup>1</sup> \* 

<sup>1</sup> Department of Soil Sciences and Water Resources, College of Agriculture, University of AL-Qasim Green, 51002 Hilla, Babylon, Iraq.

\* Corresponding Author: **Suha Al-Dulaimi** Email: [s.kamal@agre.uoqasim.edu.iq](mailto:s.kamal@agre.uoqasim.edu.iq)

**Abstract:** This research paper studies the impact of artificial intelligence as a pithiness knowledge tool in higher education. This research focuses on students exploring although the references of this study the dependency of AI in the academic field, is still limited by Deeping understanding and syllabus. Research cautions on the risk of cognitive dependency. To study this phenomenon, a structured questionnaire was adopted as a quantitative approach and was distributed to students of higher education. 190 responses were collected to describe the statically analysis to test AI usage, dependency and the Expected educational results. The findings revealed that, although there were many tools available to use within AI, students could only understand to a very limited extent. In addition the reliance on AI tools is taken to mean the short cuts rather than Deeping learning and individual thinking. Should display the concept that AI is a shallow knowledge and is centered on the gap between the widely adopted and fruitful learning result.



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**Keywords:** Cognitive shortcut, AI dependency, Critical thinking.

## 1. Introduction

Artificial intelligence (AI) tools have millions of users, including students. These assist various fields of learning in the academic environment including writing reports, solving problems and summarizing informational materials. They are now being considered as an effective tool to promote learning and enhance students' performance. The fast transformation of learning manner has been effectible. Students have a natural

inclination to utilize these resources rather than a formal requirement or compel. The rising reliance on AI-augmented tools that prompt issues of whether these tools improve students' learning experiences or instead question their ability to think independently and critically. The worry is not misguided, historically. Every wave of technological development — whether calculators or search engines — raises concerns about cognitive tradeoffs. But generative AI is different. Large language models, unlike a calculator that resolves a single, narrow well-defined problem, can write entire essays, read through dense literature, and even

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contemplate across subject boundaries. Because there are so many more things you can now do with AI, students have an unprecedented incentive to skip the very mental exercises that education is supposed to teach them [1,2]. One side argues that overreliance will dull analytical skills and limit independent thinking, while the other side points out the possibilities for AI to aid cognitive development if properly used [1].

### 1.1 AI in Higher Education and Emerging Dependency Concerns

There is real promise in bringing AI into higher education. Customized learning pathways, more comprehensive assessment methods, and informed institution-wide decision-making are just some of the practical advantages that AI can provide [3]. AI tutoring systems are also capable of monitoring individual learners and provide answers tailored to their level and pace of instruction in a way that a single tutor could not do for dozens or hundreds of students.

A recent bibliometric analysis of research in this area illustrates an exponential increase in the number of investigations focused on AI and critical thinking within HE, highlighting both the immediacy and complexity of the theme [4]. With all the benefits of artificial intelligence, concerns have been expressed that students may become too reliant on these technologies. AI products aim to facilitate learning, nevertheless when students use them to have an activity done for which they should be thinking, the learning might be negatively impacted. Research has demonstrated that offloading high-level cognitive functions such as processing of information, constructing arguments, or integrating knowledge to AI systems can decrease students' mental engagement with learning content. This, in turn, might lead to a decrease in knowledge retention and the honing of critical thinking skills[3].

The convenience that makes AI attractive is precisely what makes it risky: Taking the friction out of learning is also taking out the struggle that builds understanding. Overreliance and passivity in using AI-both present real threats to ethical reasoning, and are particularly worrisome when students accept AI-generated outputs without checking or thinking about them.

[5].This newly found dependence is not simply a case of anecdotal evidence. Concerns have been raised by researchers that over use of artificial intelligence might have adverse effects on students' cognitive development and confidence in their own abilities..the output learning is intended to let the students think independently [6],so the concerns are especial important. The students are used to using intelligence tools may be less chance to be under

critical thinking.over time the smart reliability could reduce the student's ability to think independently Studies in a variety of national settings from Denmark's national-level policy restrictions to Indonesia's school- and classroom-level empirical research demonstrate that this is a universal phenomenon, and not one contained within a particular educational system [2, 7].

### 1.2 AI as a Cognitive Shortcut

The notion of AI as a "cognitive shortcut" is at the heart of this study. A shortcut in cognitive science (also known as heuristic) is a mental method of trading completeness of the solution of a problem with the speed required to obtain that solution. Heuristics and cognitive biases are not always bad; they make up some of the most fundamental tools the human brain uses on a daily basis to make sense of the chaotic world we live in. But when a shortcut is fetishized as a way of doing business in fields that require profound processing, it becomes a liability .generative AI Generative artificial intelligence has been a boon for many students. These benefits have allowed students to use their time more productively rather than trying to get course information by preparing and studying .while this progress is important and useful for efficiency and save time, the learning experience might be different unlike traditional attain the independent effort of students, because they maybe not dive as deep into the materi

. In a recent study eLSE with 698 undergraduates, the authors report two pathways (a "dual route"): an "attentional route" of focused immersion with AI that facilitated critical thinking, and a "reliance route" of dependence on AI that predicted lower critical thinking (CT) [8]. This dual pathway finding makes clear that AI is not necessarily a negative thing -- what matters critically is whether and how students use it.

Over use unreflective use Previous Shutterstock Reviews context amount students thinking in As Consequently, students are increasingly relying on AI to execute cognitive tasks on their behalf, and critical thinking) are lost to think critically, question the information, and the source [3]. A also confirms that a similar risk that learners become cognitively dependent on AI-generated outputs rather than going through the deeper processing that is required for genuine understanding [9].And the notion that AI when used non intentionally, becomes a cognitive shortcut and not a cognitive tool, is the one that is becoming the most widely accepted among researchers that suggests that use could prevent meaningful learning and promote uniformity of thought as opposed to divergent thought [6, 10].

### 1.3 Research Problem

System Empirical studies investigating the unique pathways through which dependence on AI might influence critical thinking and content knowledge with students are scarce, SDespite the increasing awareness of these hazards. is on either the advantages of AI for education or general cautionary statements about its potential for harm, to be still exist. Although research has investigated the direct relation between AI use and critical thinking [8,11] and some have addressed ethical facets such as algorithmic bias awareness [12], there has been little research examining the three-way relationship between AI reliance, depth of understanding and critical thinking performance. This research fills that void by testing, in particular, whether thinking by way of (reliance on) AI as a cognitive shortcut hinders understanding, and whether impaired understanding then leads to weakened critical thinking.

### 1.4 Research Objectives

In this study, we have three main goals:

1. To quantify the degree of AI dependency in HE students and describe the cognitive heuristics applied when using AI as a cognitive shortcut
2. To analyze the relationships between different degrees of AI dependency and students' level of course understanding
3. To investigate the subsequent interaction among AI dependency

understanding, and critical thinking performance. In achieving these goals, the study is expected to provide a more mechanistic explanation on how AI engagement leads to cognitive outcomes instead of simple correlations between AI and cognition, to identify mediating processes.

### 1.5 Research Hypotheses

Based on the literature, the following hypotheses are proposed:

- H1: Higher levels of AI dependency are negatively associated with students' depth of understanding.
- H2: Higher levels of AI dependency are negatively associated with critical thinking performance [8,11].
- H3: Depth of understanding mediates the relationship between AI dependency and critical thinking.

These hypotheses are based on the recent empirical findings that AI dependency works through a "reliance route" that reduces cognitive engagement[8], and that the

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degradation of critical thinking is cited as a medium- to long-term risk in AI-dominated learning contexts [3].

### 1.6 Significance of the Study

This study is important for a number of reasons. First, it transcends the "AI is good" and "AI is bad" polarized debate and looks at the specific cognitive paths through which dependency is developed, a perspective that recent empirical studies have proven to be much more productive than the general "endorse" or "ban" types of attitudes [7,8]. Secondly, this research advances a more nuanced theoretical model by conceptualizing understanding as a mediator rather than simply an outcome in the relationship between dependency and critical thought. Finally, and what is most important, this result could assist educators and institutions to establish policies and recommendations for AI use based on evidence as opposed to speculation.

The demand for such evidence-based policy is made ever more pressing by the global proliferation of high-stakes institutional decisions ranging from outright bans, to wholesale integration being made with limited empirical guidance [2,5].

And finally, this study addresses calls in the literature to explore students' own views and offers practical suggestions for educators to help ensure that AI functions as a legitimate aid and not a cognitive crutch [6,10]. The investigation seeks to specify the educational implications by identifying the conditions under which an excessive reliance on AI is detrimental to the individual.

## 2. Literature Review and Conceptual Framework

### 2.1 Artificial Intelligence in Higher Education

#### 2.1.1 Current Use of AI by University Students

Universities and students are using generative AI in ways that are accelerating at a pace that outstrips institutional readiness, their uses are to consider routine use as you would things like ChatGPT for information searching, text summarization, writing support, ideation, problem solving, and coursework completion. A systematic review of AI in higher education shows that the amount of research on AI-student interactions has grown from 2021 on, shaping the scale of this transformation [13].

A quantitative study based on UTAUT2 revealed that habit and hedonic motivation were among the strongest predictors of ChatGPT adoption, indicating that usage had gone beyond being merely instrumental, and into the daily academic routines of students in Bangladesh [14].

Research on AI-based learning environments at the same side indicates that students of all disciplines now consider AI an essential part of their learning environment rather than a sporadic aid [15].

What makes the current era of uptake different from previous waves of technology integration in education is the cognitive range of tasks delegated. Formatting or spell-checking is not just the reason students use AI for an expanded reason including analyzing data, developing answers to open-ended problems scholarly intellectual labor writing letters and reviewing literature, constructing arguments and synthesizing literature “.”, AI-empowered and based tools that can modify content difficulty and pacing on-the-fly[16].

As a result of these trends, AI is revolutionizing access to information, impacting the way learners engage with information and build knowledge, and raising questions about potential changes in student cognitive engagement.

### 2.1.2 Benefits and Risks of AI-Assisted Learning

Using AI in students life is very beneficial to AI application. It has been reported that AI-based learning systems can adjust educational content according to students’ competency and learning progress, which has the potential to provide more individualized learning experiences[16]. Research has also highlighted that students can attain superior academic results when AI tools are integrated efficiently in the learning journey [17]. Risks are just as prevalent as benefits in this climate. The biggest worry is that AI might encourage students to adopt a passive learning approach: they take in outputs generated by AI without undergoing the mental activities that lead to true understanding.

A systematic review on the influence of AI on student engagement concluded that while AI enhanced engagement indicators of participation, it also raised concerns of reduced critical thinking and depth of intellectual engagement [18]. An empirical study on generative AI and deep learning (DL) explicitly warned that students could be caught in "technological dependency and cognitive inertia" — that is, become so reliant on AI-enabled workflows that they either lose the ability or motivation for performing cognitive work on their own [19].

Other threats are academic integrity-related issues emerging in an environment where there is a lack of institutional AI policy, as described in higher education of developing countries [14], and the more general anxiety that AI will shape the capabilities of students in the future in ways that are not just difficult to anticipate but perhaps also to undo.[20].

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## 2.2 AI Dependency and Cognitive Shortcut Theory

### 2.2.1 Defining AI Dependency

Dependency on Artificial intelligence (AI) can be described as a state of over-reliance on AI systems to carry out cognitive or educational tasks that the student would normally carry out on their own. It is not just every day, instrumental use: dependency conveys that a student's ability or desire to perform without AI has been significantly weakened. Studies on technology addiction in university students have reported that this addiction affects the person's cognitive, behavioral, and social interactions [2]. Qualitative data from focus group discussions further exemplifies the trend students themselves acknowledge dependence on AI as a risk and express fears around ceding autonomy over their own intellectual output [15] This paper focuses on the right end of this range the point at which AI application goes from being an enhancer of human capabilities in various tasks to a replacer of humans in those tasks.

### 2.2.2 Cognitive Offloading and Heuristic Processing

Cognitive offloading is associated with a strategy that students adopt to minimize their own cognitive load by means of external resources such as AI to read and understand content, write reports, or solve problems rather than engaging in deep processing. After reviewing effects of AI on the human mind, it can be seen that mental function manipulation is capable of decreasing intellectual vigor and critical thinking, not because of the type of knowledge produced, but rather because of changes in mental processes, as those of deep education are not anymore [21].

The systematic review on AI and student engagement confirms this mechanism by reporting that AI can promote surface indicators of engagement but that the quality of cognitive engagement can be undermined if students engage with it passively rather than actively[18]

### 2.2.3 AI as a Substitute for Cognitive Effort

Once cognitive offloading is habitual and cognitive processing becomes heuristic, AI evolves from a tool for learning to a substitute for cognition. Students don’t even think about using AI to help them think; they think about using AI so they don’t have to think. This substitutive effect is at the heart of the present study’s “cognitive shortcut” framing. Instead of doing the work to think deeply, students take the easy way out and treat AI-generated results as a surrogate for their own thinking .The effects compound and “may become mutually reinforcing.” An empirical

investigation into generative AI and deep learning concluded that as students tended to rely more on AI-generated content and less on their own cognitive efforts, they demonstrated patterns synonymous with cognitive inertia a diminished disposition to perform effortful and autonomous thinking [19].

A machine learning analysis of determinants of students' future capabilities in rapidly changing digital transformation environment also implies that how students spend their cognitive resources in AI-embedded environment strongly affects long term competency development [20]. Taken together, these results suggest a vicious feedback loop:

- Reliance dampens cognition,
- Dampened cognition undermines competence,
- Undermined competence increases future reliance.

## 2.3 Students' Understanding and Critical Thinking

### 2.3.1 Understanding in Higher Education Learning

In higher education. It involves the construction of knowledge that can be used for explanations, applications, analyses and transfer of knowledge on new situations. deep learning, is the explanation of the connections between new information and what is known, to welcome new knowledge. A blended university study examining generative AI's influence on deep learning revealed that thoughtfully designed AI learning activities have the potential to facilitate profound engagement but only with explicit pedagogical scaffolding that disallows students from passively consuming AI outputs [19].

The takeaway is that knowing is not a passive outcome of being exposed to information it takes mental work. With the application of artificial intelligence, the relevant research and teaching tasks of collecting syntheses, interpretations and arguments will be implemented. And content autonomous learning is consistent with IA posture and ethos of independent learning. When AI has facilitated that labor by giving us ready interpreted answers, answers that are condensed, positional, and arguable, then the preconditions for knowing may be subverted. This is the process through which reliance on AI is said to diminish understanding: not by getting the wrong information, but by eliminating the productive struggle through which knowledge is built.

### 2.3.2 Critical Thinking: Definition and Importance

Critical thinking is the capacity to think about information, assess the evidence and make confident decisions and it is seen as an important higher education outcome, however. skills for high quality learning, such as critical thinking, largely develop when students are given opportunities to think critically about information, assess arguments and conduct reasoning in their studies [22].

Different logical conclusions. emerge when we solve challenging problems, integrate ideas and activities and is the result of thinking leading to enacting or doing, which is what we think is. So, should AI to replace this ability , it will impact negatively on critical thinking.

### 2.3.3 Potential Impact of AI Dependency on Critical Thinking

Findings on AI and critical thinking are complex and at times seemingly contradictory. Among too many results to count, there have also been warnings that critical thinking and dependence on higher education in technology is inversely affected, and that such depends significantly on AI supports, but has been disrupting education in a uniform manner [2]. A parallel systematic review was conducted on AI and student engagement and reported that AI can promote engagement while at the same time stifling more profound forms of critical engagement, which are described as engine of intellectual growth [18].

On the other hand, the association appears to be conditional and not determinative. One experimental study reported that students who were learning with pedagogically organized AI support showed more critical thinking than those in the control groups, on the condition that the AI interaction was conceived to stimulate questioning rather than to present answers [23]. Investigations of dialogical AI (dAI) exchanges in postsecondary education indicated that learners can mature as questioners when AI serves as conversant that encourages reflection rather than produces final answers [24]. These contrasting results indicate that the influence of AI on critical thinking depends on the type of interaction. Passive, dependence-driven use seems to be detrimental; active, intentional use appears to be helpful. The present report concentrates on the former — the dependence route — and identifies the mental processes involved.

## 2.4 Previous Empirical Studies and Research Gap

The outcomes of recent empirical research (2021-2026) on AI, the learning process, and outcomes in higher

education are emerging but lack coherence. Research using multi-method approaches such as structural equation modeling, survey research, machine learning classification techniques, and qualitative studies converge on several key findings:

- AI usage is ubiquitous and growing [14,18].
- Psychological and contextual predictors of adoption differ dramatically across samples [14].
- Cognitive implications of AI use are contingent on the manner by which students use the technology [19,23] Yet.

Several salient gaps remain. First, few studies consider AI dependency as its own construct rather, most conflate dependency with usage frequency, and thus do not consider the qualitative shift from productive use to maladaptive dependence. Second, the results on learning effects are mixed: some studies show positive effects on deep learning under certain structured conditions [17,23], indicating potential unaccounted moderators or mediators of effects.

Third, Mediation models, however, are still uncommon in this literature. Although a small number of studies have investigated mediating processes such as cognitive fatigue or quality of engagement, none has conceived of students' understanding as a mediator between AI dependency and thinking critically. Fourth, the processes that might explain the relationship between dependence on AI and a decline in critical thinking are not well defined most studies report statistical relationships without providing insight into the cognitive pathway by which dependence leads to reduced analytical ability.

Fifth, to the best of our knowledge, there is practically no research on students' understanding as a mediating construct, and not a direct consequence, of AI dependency which represents a considerable theoretical blind-spot with respect to how AI dependency influences higher order cognitive skills. The current study fills these gaps by introducing and examining a mediation model in which students' understanding is the mechanism through which AI dependency is related to thinking outcomes.

## 2.5 Conceptual Framework and Hypotheses Development

H1: AI-Dependency impairs students' conceptual learning. Students taking mental shortcuts While using AI to do the cognitive work for them students fail to engage in the effortful process of development of real understanding. Externalized cognitive work is predicted to depress the internal process of knowledge construction by the theory of cognitive offloading [21].

And that's supported by empirical evidence: use of generative AI in (even in blended learning or under teacher guidance) is associated with cognitive inertia as students engage superficially with AI-generated content rather than cradling content on their own [19]. Similar to the findings of Long et al. (2026), the narrative review found that although metrics of engagement can be increased through AI, quality of cognitive engagement and consequently the level of understanding may be adversely affected when engagement is passive [18]. And so, when dependence on it is stable and unreflective, the predicted-direction is negative: dependence undermines the conditions of which deep understanding is cultivated.

H2: Dependency on AI has a negative impact on critical thinking. An analysis of technology dependency found to have negative effects on cognition and behavior in students with a strong reliance on AI [2]. An experimental study demonstrated that students in a no-structured AI support condition (using AI as they wanted and with no educational guidance) scored lower in critical thinking than those in the structured conditions, indicating that unstructured dependence on it undermine an individual's capacity to analyse [23].

The discussion of the effect of AI on human cognition aligns with this when AI replaces the need for cognitive exertion, thus the critical thinking evaluation and analysis process are not employed and they both atrophy with time [21]. These convergent lines of evidence are consistent with the prediction that reliance on AI impairs critical thinking.

H3: Understanding named students have a positive effect on critical thinking. Thinking about thinking is not blind it needs a substrate of understanding, and thinking can analyse, evaluate and reason about its substrate. Students do not have the ability to critically analyze information they have not truly learned, nor can they build solid arguments based on knowledge they have acquired through shallow means. The review of studies on critical thinking in higher education suggests that meaningful learning, knowledge building, and deep understanding are conditions for higher-order thinking [22].

The literature on deep learning in AI-based environments further suggests that since students are thought to apply higher-order cognitive skills when they genuinely understand while actively construing[19]. Understanding is the raw materials of critical thinking.

H4: Students' understanding mediates the effect of AI dependency on critical thinking. This hypothesis makes the prior three more "logical" in terms of causal pathways:

AI dependency diminishes the depth of cognitive engagement (H1), which in turn negatively affects critical

thinking (H3) due to reduced foundational knowledge in understanding, and ultimately it leads to the negative dependency to critical thinking (H2). The role of understanding as a mediating factor clarifies why reliance on AI impairs critical thought – not because it directly “turns off” one’s ability to analyze, but because it contributes to the degradation of understanding, which is the cognitive basis of critical thought. In this way, the suggested cbm model has students’ understanding as the key mediating variable within the pathway from AI dependency (exogenous variable) to critical thinking (endogenous variable).

AI dependency works through the path of less cognitive engagement in information seeking, which influences developing deep understanding. The weakened understanding also diminishes the quality of critical thinking. The model does not preclude a direct negative impact of AI dependency on critical thinking (H2), but it holds that a considerable share of this effect will be channeled indirectly through the understanding pathway (H4). This conceptualization synthesises various elements of cognitive offloading theory, heuristic processing theory and constructivist learning theory into a new integrated explanatory framework for stimulating both theoretical considerations and the development of practice based educational interventions, figure 1 explain these Hypotheses

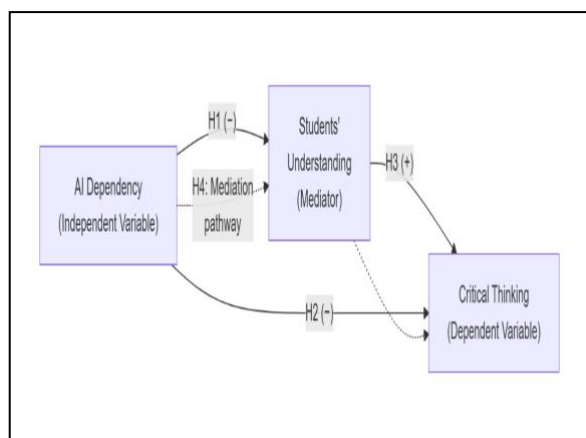


Fig 1. Proposed conceptual framework to explain the relationship between the Hypotheses

### 3. Methodology

#### 3.1 Research Design

This research employed a quantitative cross-sectional design to investigate the relationships between AI dependency, students’ perceptions, and critical thinking in tertiary education. A quantitative method was chosen as the study objectives involve measurement of latent constructs, testing of directional hypotheses, and examination of mediation paths all of which require numerical data that can

be subjected to inferential statistical analysis. Cross-sectional studies are well fit for studying the prevalence of a phenomenon as well as for exploring relationships between variables at a particular point in time [25]. cross-sectional designs continue to be the most commonly employed methodological approach in educational and psychological research to testing theoretically derived structural models, especially when the collection of longitudinal data is unfeasible despite it couldnt establish temporal causality in the strict experimental sense[26] The suitability of cross-sectional survey designs to examine associations between patterns of technology use and cognitive outcomes in higher education has been demonstrated in previous empirical work on AI dependency and related psychological constructs.[27, 28]

### 3.2 Participants and Sampling

#### 3.2.1 Target Population

The study population consisted of the students of Babylon University and Al-Qasim Green University in the city of Babylon. Why university students? Firstly, university students are the generation that is the "early adopter" of generative AI tools within academic workflows and thus the population most immediately impacted by potential dependency effects. Second, two important outcomes of higher education are critical thinking and deep understanding.

Third, examining students at two universities in one city allows the n within universities to be large enough to provide a significant diversity for the purpose of generalization while holding broad regional/cultural influences constant.

#### 3.2.2 Sampling Method

Convenience sampling is the most prevalent sampling technique in educational and psychological research, and when a result is presented with reasonable caution about its generalizability, it may derive valid and informative conclusions [29]. Questionnaires were spread via several means to increase potential access and response rate: WhatsApp groups, Facebook Messenger, email through departmental contacts, and in person during classes and on campus.

The goal in utilizing multi-mode distribution was to minimize selection bias associated with any single recruitment strategy (for example, by reaching students who are least active on social media through an in-person distribution and students are harder to approach on campus via digital option).

### 3.2.3 Sample Characteristics

The samples comprised male and female undergraduate and postgraduate students a range of faculties and departments was included to ensure the diversity of responses. Likewise, by having undergraduate and postgraduate students, the study can test whether the relationships between AI dependency, comprehension, and critical thinking are different across levels of academic maturity. Detailed demographic details of the final sample are provided in the results section.

## 3.3 Questionnaire Development

### 3.3.1 Instrument Development Process

The development of the instrument was guided by a structured procedure consisting of three phases: reviewing literature, adapting items and designing the instrument. Firstly, a review of the literature on AI dependency, cognitive offloading, students' self-perceived understanding, and critical thinking in higher education was conducted to determine main dimensions and indicators of each construct. Second Adapted the items to the context from the validated instruments of prior empirical studies on AI use and cognitive outcomes in education[28,30].

In cases where the existing items could not sufficiently represent the specific aspects that were important for this study especially the cognitive shortcut aspect of AI dependency new items were written based on theoretical definitions, as established by the literature. Third ,the approved items were prepared in the form of a structured questionnaire using Google Form, which was selected because of its availability, the convenience in sending out the questionnaire as well as the function of collecting data.

### 3.3.2 Questionnaire Structure

The questionnaire consisted of five sections, each targeting a distinct construct or set of background variables:

first: Demographic Information.

Demographic information including gender, age, education level (undergraduate, postgraduate), field of study, and affiliated university was collected in this section. These variables will be used to characterize the sample descriptively and as potential control variables in analyses that follow.

second: AI Usage Patterns. This part evaluated the present use of AI tools by respondents. Items concerned whether respondents used an AI tool, in this case ChatGPT, how often (e.g., daily, weekly, rarely), the average number of hours per day of usage, and what purposes for which AI was used.

Uses Were inquired about through a multiple-choice questionnaire with the following alternatives: to understand course content; to carry out assignments; to write reports; to summarize; content; to generate ideas; and for other academic purposes. This segment offers background information on participants' academic day-to-day lives and how much if at all AI featured in those.

third. Dependence on AI This variable measures the extent to which students tend to rely on artificial intelligence in doing educational activities. It represents a change in behavior from AI as a "cognitive assistant" to being a "cognitive substitute", where it may supplant one's own cognitive effort and independent thinking in assignments, rather than simply acting as a tool to use in coursework and problem-solving.

To this end, the research exploited" indicators of perceived reduced academic autonomy and the frequent replacement of automated tools for the "productive struggle "traditionally associated with independent study academics .fourth. Students' Understanding Depth of students' understanding is defined as the extent of conceptual understanding which enables students to properly comprehend, integrate, and apply learning materials.

In this study, the construct is concerned with whether AI serves as a "cognitive scaffold" that makes intricate information easier to understand and assists students in developing significant knowledge frameworks. It was evaluated based on students' perceptions of their learning improvement, particularly their capacity to explain difficult topics in their own language and to assist in a clearer understanding of subjects after benefiting from ai tools .fifth. Critical Thinking Critical thinking is the ability to think about thinking in a manner that is purposeful, reflective, and involves higher cognitive processing. The definition is centered around active vs. passive learning of student with an m-GAI in such as AI-generated content in this study context. Rather than assessing general reasoning skill, the concept focuses on the degree to which students critically evaluate AI answers for accuracy and bias, and their concerns about the possible emergence of "cognitive inertia" through too much reliance on technological innovation.

### 3.3.3 Scale Design

The third, fourth, and fifth sections used a five-point Likert scale with options ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). Likert-type questions are widely accepted as the standard measurement type for attitudinal and perceptual constructs within educational research because of its ability to provide a good balance between sensitivity of measurement and ease of response.. second

paragraph contained items with multiple-choice and yes/no response options for questions where the measurement was categorical and not scalar — for example, which AI tools are employed and for what uses. The variation in response styles between sections is motivated by the different measurement needs of each construct: scalar for latent attitudinal constructs and categorical for behavioral and demographic constructs.

### 3.4 Data Collection Procedure

the structured Google Forms questionnaire was the way for collecting data, it distributed via university networks and social media platforms over a period of eight weeks. a brief introduction explaining the research purpose, the voluntary nature of participation was the introduction of the questionnaire. a brief introduction explaining the research purpose, the voluntary nature of participation.

Responses with substantial missing data — defined as omission of more than 20% of required items — were excluded from the final analytical sample. The remaining responses were coded, cleaned, and prepared for statistical analysis.

### 3.5 Ethical Considerations

The study was performed in accordance with the principles of the Declaration of Helsinki. Participation was wholly voluntary, with no academic rewards or penalties, nor any coercive implication for participation or non-participation. Informed consent was digital: after reading a plain language statement outlining the aims of the study, the type of data being collected and what we intend to do with their responses, participants consented to continue. All answers were anonymous :

we did not ask for any personally identifiable information such as names, student ID number, or email address. The information was kept private and could only be accessed by the researchers. Respondents were notified that they may stop participating at any time during the survey without any loss.

All the information gathered from you will be strictly confidential and used only for academic research and will not be divulged to any third party or used for commercial purpose.

#### 1. Executive Summary of Findings

Summary conclusion The most robust and consistent result is that students who view AI as supporting their understanding of the course materials also indicate that they can better explain ideas and do better in their classes . However

- The correlation between AI dependence and comprehension is positive but weak
- .AI dependence and critical thinking are not significantly related
- There is no significant association between understanding and critical thinking .This indicates that instead of directly taking over the thinking process of students, AI functions as a aid tool for learning, as shown in table 1.

## 2. Descriptive Statistics

**Table 1. Mean Scores and Standard Deviations for Students' Perceptions of AI Use**

Variable	Mean	SD
AI helps me understand course materials better	4.01	1.37
I can explain material more clearly after using AI	3.79	1.41
I rely on AI instead of my own thinking	3.16	1.60
I can solve problems without AI	3.62	1.32
AI reduces my effort in deep thinking	3.55	1.54
AI improves my academic performance	3.44	1.37
AI makes me less independent in learning	2.84	1.47
AI is beneficial in higher education	3.81	1.52
AI may negatively affect critical thinking	3.50	1.35
Universities should regulate AI use	3.46	1.58
I trust AI-provided information	3.18	1.36

### Interpretation

Students generally:

- Agree that AI improves understanding.
- Agree that AI helps explain concepts.
- Agree that AI improves performance.
- Show only moderate agreement that AI replaces their own thinking.
- Show only moderate agreement that AI harms critical thinking.

## 3. Composite Scale Analysis

The following composite indices were constructed:

### AI Dependency Index

Based on:

- Reliance on AI instead of personal thinking
- Reduced effort in deep thinking
- Reduced learning independence
- Trust in AI information

## Understanding Index

Based on:

- AI helps understanding
- AI helps explanation

## Critical Thinking Index

Based on:

- Ability to solve problems without AI
- Reverse-coded item regarding negative effects on critical thinking

## A. AI Dependency ↔ Understanding

Result

- $r = 0.156$
- $p = 0.032$

Interpretation

This relationship is statistically significant but weak.

Students who are more dependent on AI tend to report slightly greater understanding.

Effect size is small.

This supports the cognitive-shortcut hypothesis only marginally.

## B. AI Dependency ↔ Critical Thinking

Result

- $r = 0.013$
- $p = 0.859$

Interpretation

No statistically significant relationship.

Students who rely more heavily on AI do not appear to have measurably lower critical-thinking scores in this dataset.

This finding directly challenges the stronger version of the cognitive-shortcut hypothesis.

## C. Understanding ↔ Critical Thinking

Result

- $r = 0.072$
- $p = 0.325$

Interpretation

No statistically significant relationship.

Perceived understanding gains do not correspond to stronger critical-thinking outcomes.

**4. Important Correlations**

Understanding ↔ Explanation Ability

Result

- $r = 0.690$

- $p < 0.001$

Interpretation

This is the strongest relationship in the dataset.

Students who believe AI improves understanding also report being able to explain material more clearly.

This strongly supports the educational usefulness of AI.

Understanding ↔ Academic Performance

Result

- $r = 0.399$
- $p < 0.001$

Interpretation

Moderate positive relationship.

Students who perceive greater understanding also report better academic performance.

Explanation Ability ↔ Academic Performance

Result

- $r = 0.375$
- $p < 0.001$

Interpretation

Students who report improved explanatory ability also report improved academic outcomes.

Reduced Deep Thinking ↔ Reduced Independence

Result

- $r = -0.460$
- $p < 0.001$

Interpretation

That's an intriguing result and should be investigated further. The association is statistically significant, but in the inverse direction of what most researchers would expect. Students who say they think less deeply don't necessarily say they become less independent learners to the same extent.

This may indicate:

- Different interpretations of "deep thinking" and "independence"
- Measurement issues
- A more complex relationship than assumed in the theoretical model

**5. Evidence Supporting the Cognitive Shortcut Hypothesis**

The following findings support the idea that AI can function as a cognitive shortcut:

- Supporting Evidence
- Students moderately agree that:
- AI reduces effort in deep thinking
- Mean = 3.55

Students moderately agree that:

- AI may negatively affect critical thinking
- Mean = 3.50

AI Dependency is positively associated with Understanding

- $r = 0.156$
- $p = 0.032$

These findings suggest that some students obtain learning benefits while potentially offloading portions of **their cognitive effort to AI systems.**

#### 6. Evidence Challenging the Cognitive Shortcut Hypothesis

Several findings challenge the hypothesis:

No relationship between AI Dependency and Critical Thinking

- $r = 0.013$
- $p = 0.859$

No relationship between Understanding and Critical Thinking

- $r = 0.072$
- $p = 0.325$

Strong educational benefit indicators

Students report:

- Better understanding
- Better explanations
- Better academic performance

without corresponding evidence of lower critical-thinking capability.

This suggests AI may often function as a cognitive scaffold rather than merely a shortcut.

#### 7. Implications for Higher Education

Implication 1

AI appears to support comprehension and communication of academic content.

Implication 2

There is insufficient evidence to conclude that AI dependency directly harms critical thinking.

Implication 3

Students perceive both benefits and risks simultaneously:

Improved understanding

Reduced thinking effort

Potential concern about critical-thinking decline

Implication 4

Universities should focus on teaching:

AI literacy

Verification of AI outputs

Evidence evaluation

Prompt engineering

Critical reflection

rather than restricting AI use outright.

#### 8. Suggestions for Further Qualitative Inquiry

The quantitative results raise several important questions.

Understanding

"What does 'understanding better' actually mean to students?"

Is it:

Memorisation?

Conceptual understanding?

Faster learning?

## 4. Discussion

This research investigated if AI serves as a cognitive shortcut in the context of higher education by exploring the correlation between AI reliance, student comprehension, and higher order thinking. The results present a nuanced picture. While students overall reported that AI was helpful to furthering understanding, explaining concepts and for academic success, a negative association between dependency on AI and critical thinking was not found. These findings insinuate that AI can be both a learning tool and a cognitive shortcut, contingent on its application.

### 4.1 Interpretation of Results

The study's findings highlight that students view AI as an integral component of their learning ecosystem

. There is strong perceptual endorsement for AI's role in simplifying difficult content ( $M=4.01, SD=1.37$ ) and improving subject-matter communication ( $M=3.79, SD=1.41$ ). The strong linear relationship between these two variables ( $r=0.690$ ) confirms that AI-assisted understanding is a primary driver of student confidence in academic expression

Additionally, the weak yet significant association between AI reliance and understanding ( $r=0.156, p=0.032$ ) indicates that while students may use AI as a "cognitive shortcut" to manage academic friction, the actual impact on their depth of understanding remains limited. Most significantly, the research found no detectable correlation between AI dependency and critical thinking performance ( $p=0.859$ ), nor between understanding and critical engagement ( $p=0.325$ ).

This suggests that while AI can enhance the efficiency of information access, it currently functions as a support tool that operates independently of a student's ability to critically analyze, evaluate, or question information.

#### 4.2 AI Dependency as a Cognitive Shortcut

The present study is considered to regard AI of "cognitive shortcut," That is, the main work shifting to automated tools to reduce its user's cognitive friction. The survey data support that students perceive this transfer by agreeing that AI eases the thinking required by depth thinking ( $M=3.55, SD=1.54$ ), but it's have different meaning, composited with risk of weakening critical reasoning ( $M=3.50, SD=1.35$ ). These numbers reflect that students do frequently use AI for helping with labor-intensive thinking in the daily academic routine.

Yet despite such perceptions, the findings flew in the face of the "reliance pathway" model according to which greater reliance would be associated with poorer critical thinking. As no significant association was found between these variables ( $p=0.859$ ), the results may imply that the "shortcut" that students take is perhaps limited to superficial thinking rather than a complex mental process. Therefore, results may suggest that AI in HE could be considered a mediating tool to support learning by taking care of routine cognitive tasks, without undermining core intellectual skills that education strives to nurture.

#### 4.3 Implications for Student Understanding and Critical Thinking

The results imply that through offering easy-to-understand explanations and individualized assistance, AI can improve students' sense of understanding. The positive correlations between understanding and the academic performance suggest that learning with the support of AI may lead to better educational outcomes.

Students seem to take advantage of the ability of AI to break down complex concepts and to offer real-time responses. Nevertheless, the absence of a relationship between understanding and critical thinking is a cause for

serious concern. Students may be more confident in what they know, but not have necessarily developed deeper thinking about what they know.

This distinction is consistent with the possibility that AI promotes surface processing of information to a greater extent than HOI processing. Hence, teachers should be wary of treating enhanced understanding as equivalent to authentic critical engagement.

#### 4.4 Comparison with Previous Research

The results both confirm and extend prior work on AIED. Kasneci et al. (2023) and Tlili et al. (2023), contributed to a stronger understanding on the educational potentials of generative AI, specifically as a means to broaden the access to information, to foster personalised learning, and to increase academic productivity.

The observed positive correlations between AI use and understanding and the academic performance in this study are in line with these results. At the same time, the participants did express a certain degree of worry related to cognitive offloading and overdependence on AI which are concerns that have been previously voiced in the literature. Prior research has indicated that overreliance on AI-generated answers might limit one's ability to think independently.

Yet, it found no empirical support that the reliance on AI damages critical thinking however, the authors argue that the hierarchical framework of critical thinking could have led to some underestimation of the results. This inconsistency may suggest that the link between AI and CT may be more intricate than has been previously understood and may be influenced by some shadow factors used patterns, academic discipline and digital literacy, among others).

#### 4.5 Educational Implications

The results suggest that higher education institutions should adopt a balanced approach to AI

Humanized task, integration. Instead of banning AI, universities should be teaching students how to be literate and critically engaged in AI. Students require guidance in "assessing, fact-checking, source-checking and stacking up AI on the knowledge with which they already have, not letting AI replace their own thinking." Adaptations to assessment may also be necessary.

Traditional assignments that focus on retrieval of information and summarisation are increasingly susceptible to being aided by AI. To this end, instructors

should construct test items that prompt students to analyze, evaluate, reflect on, and justify their thinking.

These strategies can promote critical thinking among students when engaging with AI-generated outputs and at the same time allow students to benefit from AI in an educational setting. Generally speaking, these results indicate that AI has great promise for improving learning and comprehension in university-level education. However, to fully harness these benefits, pedagogical approaches need to support active learning and critical reflection, so that AI is perceived more as a cognitive scaffold and less as a cognitive shortcut.

#### 4.6 Study Limitations

There are a number of firm limitations in the study design that need to be accounted for when interpreting the results. First, the data came from perceptual surveys rather than objective measures of students' mastery of the courses, which could result in a gap between what students perceived about their mastering ability and their actual intellectual performance.

Second, the cross-sectional design's snapshot approach hinders the enumeration of temporal causality of patterns of AI use and cognitive outcomes. Finally, critical thinking was measured by perception-based questionnaire items rather than validated critical-thinking tools. Studies based on objective tools may yield different results and offer a better estimation of cognitive outcomes.

#### 4.7 Recommendations for Future Research

Subsequent investigations should further monitor the impact of AI on student learning for even longer durations. This would provide insights as to whether daily exposure to AI could have an impact on the way students think critically and solve problems and, as a result, their performance in school. The researchers would do well to employ methodologies that capture how students actually perform, rather than simply taking their word for it.

For instance, academic tests, critical-thinking tests, and learning tasks might be used in future research to directly measure students' abilities. Lastly, qualitative methods, such as interviews and focus groups, as well as observations of students in the classroom, could investigate in more depth the ways in which students employ AI, the kind of tasks they give to AI, and the cognitive operations they perform when engaging with AI-produced materials.

### 5. Conclusions

The implication is that AI is a powerful instrument in increasing comprehension, making explanations in science more accessible, and enhancing students' performance in school. Understanding is strongly positively correlated to explanatory ability. The students who think that AI contributes to better understanding are also more confident in telling others what they have learned.

These results suggest that AI can be an effective learning tool, as it enables students to have immediate access to information, offers personalised explanations, and provides support with their studies. While a statistically significant positive correlation between AI dependency and perceived understanding was found, the effect size was somewhat small. This indicates that increased engagement with AI is linked with somewhat higher levels of confidence among students in their understanding of the academic content.

However, the weak intensity of the association implied that the degree of AI dependency by itself was not a sufficient factor to explain the differences in students' learning and understanding. This study illustrates an equally balanced interpretation of the cognitive shortcut hypothesis.

AI can ease some cognitive demands by giving quick answers, explanations and information. On the other hand, the research implies that technology, in particular AI, is regarded more as a facilitator for the acquisition of knowledge and learning rather than as a substitute for thinking and processing. Hence, the effect of AI on education may be determined less by the technology itself and more by the manner in which students elect to use the technology in learning activities.

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#### References

- [1] L. Lim *et al.*, "Effects of artificial intelligence utilization on students' cognitive development and critical thinking dispositions at secondary and higher education levels," *Int. J. Soc. Sci.*, vol. 4, pp. 118–129, 2026.
- [2] A. Miller, "The impact of technology dependency in higher education: A critical examination of cognitive, behavioural and societal outcomes," *World J. Adv. Res. Rev.*, vol. 29, no. 3, pp. 1974–1991, 2026, doi: [10.30574/wjarr.2026.29.3.0738](https://doi.org/10.30574/wjarr.2026.29.3.0738)

- [3] M. Özer, H. Tanberkan, and M. Perc, "Artificial intelligence threatens critical thinking in education systems," *J. Higher Educ. Sci.*, vol. 15, no. 2, pp. 157–164, Aug. 2025, doi: [10.5961/higheredusci.1747885](https://doi.org/10.5961/higheredusci.1747885)
- [4] K. R. Menikdiwela, P. Muthukrishnan, P. M. I. Seraj, G. Subramaniam, and W. Meng, "Bibliometric analysis on artificial intelligence and critical thinking skills of higher education students," *Asian J. Univ. Educ.*, vol. 22, no. 1, pp. 1–20, Feb. 2026, doi: [10.24191/ajue.v22i1.001](https://doi.org/10.24191/ajue.v22i1.001)
- [5] D. Conti, G. Romeo, and S. Di Nuovo, "Generative artificial intelligence in higher education: Opportunities, risks, and the future of critical thinking and human reasoning," 2026, pp. 9–24.
- [6] L. Favero, J.-A. Pérez-Ortiz, T. Käser, and N. Oliver, "Do AI tutors empower or enslave learners? Toward a critical use of AI in education," *arXiv*, Jul. 2025, doi: [10.48550/arXiv.2507.06878](https://doi.org/10.48550/arXiv.2507.06878)
- [7] R. S. Ridlo, F. S. Iliasu, and S. Ma'rufah, "AI-mediated critical thinking: A double-edged sword in Indonesian higher education," *Attaqwa: J. Ilmu Pendidikan Islam*, vol. 22, no. 2, pp. 128–138, 2026.
- [8] J. Tian and R. Zhang, "Outsourcing thinking to AI? Focused immersion, AI dependency, and the double-edged impact on critical thinking," *Humanit. Soc. Sci. Commun.*, 2026, doi: [10.1057/s41599-026-07153-8](https://doi.org/10.1057/s41599-026-07153-8)
- [9] M. Maslan and N. Ubaidah, "Artificial intelligence in education and its conditional impact on critical thinking: A systematic literature review," *J. Didactical Math.*, vol. 8, no. 1, pp. 187–203, 2026.
- [10] Y. Li *et al.*, "The improvement or hindrance of the new generation of artificial intelligence: The role of ChatGPT in critical thinking skills," *Int. J. Inf. Technol. Syst. Approach*, vol. 19, pp. 1–24, 2026.
- [11] Z. Naz, H. M. Baig, and S. Parveen, "Artificial intelligence and the decline of critical thinking: A hidden academic crisis in contemporary education systems," *Rev. Educ. Adm. Law*, vol. 9, no. 1, pp. 53–65, 2025, doi: [10.47067/real.v9i1.472](https://doi.org/10.47067/real.v9i1.472)
- [12] J. Popalia *et al.*, "AI dependency and critical thinking in higher education: A life-course perspective on ethical awareness and algorithmic bias," *Artif. Intell. Lifelong Life-Course Educ.*, vol. 1, pp. 13–23, 2026.
- [13] D. Long *et al.*, "Artificial intelligence in higher education: A systematic review of its impact on student engagement and the mediating role of teaching methods," *Front. Educ.*, vol. 10, 2026.
- [14] M. G. Kibria *et al.*, "Determinants of ChatGPT adoption in higher education: An empirical study on public and private university students in Bangladesh," *Glob. Bus. Rev.*, 2026, doi: [10.1177/09721509261443740](https://doi.org/10.1177/09721509261443740)
- [15] T. D. Putranto, D. Sofiah, and H. S. Ramadhani, "Understanding university students' learning engagement in AI-supported learning environments: An empirical study," *J. Paedagogy*, vol. 13, no. 1, pp. 222–232, 2026.
- [16] T. Yuensook, T. Jantakoon, and P. Limpinan, "AI-driven adaptive learning systems in higher education: A systematic review," *J. Educ. Learn.*, vol. 15, p. 117, 2025.
- [17] V. Girish *et al.*, "Harnessing artificial intelligence for smart learning: An empirical study on student academic performance," *J. Mark. Soc. Res.*, vol. 2, pp. 1–11, 2025.
- [18] W. Zhang, B. Chen, and C. Tang, "An empirical study on the impact of generative artificial intelligence-based learning activities on college students' deep learning," *Res. Pract. Technol. Enhanc. Learn.*, vol. 21, p. 028, 2026.
- [19] Y. Chen and H. Wu, "Identifying dominant and heterogeneous factors influencing students' future capabilities under the digital transformation of higher education: A machine learning approach," *Interact. Learn. Environ.*, pp. 1–21, 2026.
- [20] R. Gesnot, "The impact of artificial intelligence on human thought," *arXiv*, 2025, doi: [10.48550/arXiv.2508.16628](https://doi.org/10.48550/arXiv.2508.16628).
- [21] N. Rothinam *et al.*, "Systematic literature review on critical thinking in higher education," *Edelweiss Appl. Sci. Technol.*, vol. 9, no. 5, pp. 2046–2063, 2025.
- [22] R. Yavich, "Will the use of AI undermine students independent thinking?" *Educ. Sci.*, vol. 15, no. 6, p. 669, 2025.
- [23] P. Brazão and L. Tinoca, "Artificial intelligence and critical thinking: A case study with educational chatbots," *Frontiers Media SA*, 2026
- [25] S.-E. Baumeister *et al.*, "Cross-sectional studies: Strengths, limitations, and methodological considerations," *J. Periodontal Res.*, 2026, doi: [10.1111/jre.70063](https://doi.org/10.1111/jre.70063)
- [26] C. Maier, J. B. Thatcher, V. Grover, and Y. K. Dwivedi, "Cross-sectional research: A critical perspective, use cases, and recommendations for IS research," *Int. J. Inf. Manage.*, vol. 70, p. 102625, Jun. 2023, doi: [10.1016/j.ijinfomgt.2023.102625](https://doi.org/10.1016/j.ijinfomgt.2023.102625)
- [27] W. Zhong, J. Luo, and Y. Lyu, "How do personal attributes shape AI dependency in Chinese higher

- education context? Insights from needs frustration perspective," *PLoS ONE*, vol. 19, no. 11, p. e0313314, Nov. 2024, doi: [10.1371/journal.pone.0313314](https://doi.org/10.1371/journal.pone.0313314)
- [28] D. Zhang *et al.*, "Exploring the relationship between AI literacy, AI trust, AI dependency, and 21st century skills in preservice mathematics teachers," *Sci. Rep.*, vol. 15, art. no. 14281, Apr. 2025, doi: [10.1038/s41598-025-99127-0](https://doi.org/10.1038/s41598-025-99127-0)
- [29] S. E. Scholtz, "Sacrifice is a step beyond convenience: A review of convenience sampling in psychological research in Africa," *SA J. Ind. Psychol.*, vol. 47, art. no. a1837, 2021, doi: [10.4102/sajip.v47i0.1837](https://doi.org/10.4102/sajip.v47i0.1837)
- [30] A. Kulal, "Cognitive risks of AI: Literacy, trust, and critical thinking," *J. Comput. Inf. Syst.*, pp. 1–13, 2025, doi: [10.1080/08874417.2025.2582050](https://doi.org/10.1080/08874417.2025.2582050)

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