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Research Article

How Does Artificial Intelligence Affect Creative Problem-Solving Ability of College Students: The Mediating Role of Creativity Self-Efficacy

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Abstract

This study focuses on exploring the impact of Generative Artificial Intelligence (Gen AI) on college students' creative problem-solving abilities and verifying the mediating role of creativity self-efficacy in this process. We conducted a questionnaire survey among 373 college students and analyzed it using data statistics methods such as structural equation models. The research results show that the use of generative artificial intelligence has a significant positive predictive effect on college students' creative problem-solving ability, and this influence is partly achieved through the mediating path of creativity self-efficacy. This study delves deeply into the intrinsic mechanism by which Gen AI promotes students' innovative behaviors by reinforcing their creative self-beliefs, providing empirical support and practical guidance for universities to optimize their innovative education models in the context of the era of artificial intelligence.

Keywords: Generative Artificial Intelligence; College student; Creative problem-solving ability; Creativity Self-efficacy

Introduction

Innovation, as the primary driving force for development, cultivating innovative talents is the core pillar for the country to implement the innovation-driven development strategy. Programmatic documents such as "China Education Modernization 2035" emphasize the need to accelerate the cultivation of high-quality talents with innovative capabilities and the ability to solve complex problems. Higher education has an inescapable responsibility in this regard and should focus on shaping students' creative thinking and practical abilities. Against this backdrop of The Times, whether college students possess creative problem-solving abilities is by no means merely about their personal growth

and progress; it plays a direct and crucial role in the country's future talent competitiveness and the level of scientific and technological innovation.

In recent years, artificial intelligence technology has shown a rapid development trend and has become a key force driving the transformation of the education field. From the application of intelligent tutoring systems to the popularization of automatic code generation technology, and then to the rise of cross-modal content creation and the realization of complex decision-making simulation, artificial intelligence has provided college students with highly innovative cognitive tools and unique innovation platforms. In the daily study of college students, the application scope of artificial intelligence is constantly expanding, from assisting in material search to integrating into every aspect of daily study, and even playing an important role in providing ideas and solutions for problem-solving. Even in fields that require innovation capabilities, artificial intelligence has more and more places to be put to use. At present, most students are proficient in using artificial intelligence. Among the four typical scenarios of course study, daily life, scientific research activities and promotion and further education, the application frequency of artificial intelligence is the highest in the scientific research activity scenario, which fully demonstrates that artificial intelligence has a significant promoting effect on college students' scientific research activities [1].

It can be seen from this that generative artificial intelligence is highly likely to have an impact on college students' creative problem-solving abilities. In view of this, we can't help but consider two key questions: First, "Can artificial intelligence really enhance college students' ability to solve problems creatively?" Secondly, "What is the internal mechanism of interaction between artificial intelligence and college students' creative problem-solving abilities?" However, most current research focuses on the relatively superficial impact of Gen AI on academic performance and other outputs. There is still a lack of in-depth and systematic exploration of the internal psychological mechanisms by which Gen AI affects college students' creative problem-solving abilities.

Numerous studies have confirmed that self-efficacy in creativity has a positive promoting effect on individual creativity [2,3]. This research finding leads us to consider that the intrinsic mechanism of interaction between artificial intelligence and college students' creative problem-solving abilities might be achieved through creative self-efficacy. Based on this, we will further delve into the issue and raise the question: "Will artificial intelligence have an impact on college students' creative problem-solving abilities through creative self-efficacy?" And "Is the effect of artificial intelligence on college students' creative problem-solving ability through creativity self-efficacy significant?" These two key issues.

The research results of scholars such as [4] show that GenAI can indirectly promote the improvement of students' academic performance by enhancing their self-directed learning ability. This discovery suggests that self-efficacy may play a crucial mediating role in the connection between artificial intelligence and creativity. Based on this, this study initially constructed a theoretical model of "Gen AI--- creativity self-efficacy---creative problem-solving ability". However, empirical research on this mechanism chain is still in its infancy at present. Can Gen AI and through what specific means have an impact on students' creative problem-solving abilities by enhancing their creativity self-efficacy? These questions urgently need more in-depth exploration.

Therefore, to fill the above research gap, this study intends to explore the following question: Can the application of Gen AI have a significant predictive effect on college students' creative problem-solving ability? Does creativity self-efficacy play a mediating role between Gen AI and creative problem-solving ability? To address these issues, this study plans to use the method of questionnaire survey to collect relevant data from college students, build a theoretical model with creativity and self-efficacy as mediating variables, and conduct empirical verification using the structural equation model (SEM). This research aims to provide theoretical support and practical approaches for the application of artificial intelligence in education and the cultivation of innovative talents in colleges and universities.

Literature Review and Research Hypotheses

The Relationship between Gen AI and Creative Problem-solving Ability

In recent years, generative artificial intelligence technologies (such as GPT, Kimi, DeepSeek, etc.) have shown a rapid development trend and demonstrated huge application potential in many fields including education, scientific research and creation. By leveraging functions such as natural language processing, multimodal generation, and interactive dialogue, Gen AI can provide users with a rich variety of initial solutions, significantly reducing the difficulty of creative conception and problem-solving [5]. Research shows that Gen AI not only broadens an individual's cognitive horizons but also stimulates users' divergent thinking through immediate feedback and iterative interaction.

Taking the research of [6], as an example, they found that when in an environment where Gen AI is more prominent, individuals tend to actively apply strategies to redefine the dimension of differences in capabilities between humans and Gen AI, thereby more effectively responding to the challenges brought by Gen AI to their own uniqueness. The application of this strategy can not only alleviate the anxiety caused by the development of Gen AI among humans, but also deepen human understanding of their own creative abilities. In the field of creative problem-solving, Gen AI can assist users in completing a series of key steps such as problem identification, information integration, solution conception, and evaluation [7]. Wang M, et al. [8] emphasized that high-quality technical tools and favorable environmental support can directly enhance students' performance in creative problem-solving. However, at present, most studies still mainly focus on the instrumental attributes of Gen AI and its output results, and relatively few delve into the impact of Gen AI on an individual's creative problem-solving ability from the psychological mechanism level.

Mediating mechanisms of Creativity Self-efficacy

Creativity self-efficacy refers to an individual's assessment of their confidence in their ability to produce creative outcomes [9]. Students with a higher sense of creative self-efficacy are more willing to set challenging goals, will unswerving carry out innovative attempts, and demonstrate more tenacious perseverance when encountering difficulties [10]. Chen Y [11] demonstrates that different types of achievement motivation (such as aggressive and challenging) have a significant impact on an individual's level of creative self-efficacy, thereby influencing their creative performance. Gen AI can create a low-risk and high-feedback creative environment, helping students gradually build confidence that "I have the ability to create". For instance, Gen AI can offer tailor-made learning resources and provide real-time support to help users master complex knowledge more efficiently, thereby strengthening their self-belief in completing creative tasks [8]. This belief not only directly affects an individual's creative performance but may also build a bridge of communication between external technical support and creative output. Based on this, this study infers that creative self-efficacy may play a mediating role between the use of Gen AI and creative problem-solving ability.

Research Hypothesis Model

In conclusion, this study constructs the following theoretical model:

a) Hypothesis 1 (H1): Gen AI uses positive prediction to predict the creative problem-solving ability of college students.

b) Hypothesis 2 (H2): Creativity self-efficacy plays a mediating role between the use of Gen AI and creative problem-solving ability.

This study aims to reveal the promoting effect of Gen AI on students' innovation ability in higher education and its psychological mechanism, providing theoretical basis and practical suggestions for universities to optimize the cultivation of innovative talents in the era of artificial intelligence.

Research Methods

Research Resources

In this study, the research focused on the group of current college students, with students from Zhaoqing University being particularly selected as the specific research subjects. After a strict screening of the returned questionnaires and the elimination of invalid ones, a total of 373 valid samples were finally obtained. From the perspective of the composition of the sample, in terms of gender dimension, there are 156 male students, accounting for 41.82%. There are 217 female students, accounting for 58.18%. In terms of grade distribution, there are 112 freshmen, accounting for 30.03%. The number of sophomores is the largest, reaching 173, accounting for 46.38%. There are 88 junior students, accounting for 23.59%. Based on the various data composed of the above samples, it can be found that this sample shows a relatively wide distribution trend in terms of gender and grade, etc., which can well meet the specific requirements of this research analysis.

Research variables and Tools

Independent Variable

The design of this part of the questionnaire refers to the "Questionnaire on the Current Usage Status of Gen AI among College Students" compiled by [2], and at the same time combines the research of [12]. On the current status of artificial intelligence literacy and ability among college students. The questionnaire covers aspects such as the intensity of students' use of Gen AI, the depth of application, and students' perceived value of Gen AI learning resources, with a total of 8 questions set. The five-point Likert scoring method is adopted. The higher the score, the greater the degree to which students use Gen AI. After testing, the Cronbach's α coefficient of the scale was 0.78 and the KMO value was 0.830, which fully demonstrated that the questionnaire had good reliability and validity.

Dependent Variable

The creative problem-solving ability questionnaire in this study is carefully designed and adapted based on the creative problem-solving ability scale developed by [13], closely combined with the current application status and development trend of Gen AI among college students. This scale covers four key dimensions, namely problem construction and identification, idea generation, idea evaluation, and idea implementation, and contains a total of 8 questions. In terms of scoring, a Likert 5-point scale was adopted, with a scoring range of 1 to 5 points. Generally speaking, the higher the score, the stronger the ability of the subject in creative problem-solving. In this study, the overall Cronbach's α coefficient of this scale reached 0.776, and the KMO coefficient was 0.840. This series of data strongly demonstrates that the scale has high internal consistency and reliability, and can accurately measure the creative problem-solving ability of the subjects.

Mediating Variables

The Creativity Self-Efficacy Scale was adapted by [14], and it covers items such as "I can achieve most of the goals I set for myself in a creative way" and "I can overcome many challenges in a creative way". In this study, we adapted the original scale based on the application status of Gen AI among college students. The new scale consists of a total of six questions, such as "I firmly believe that I have the ability to solve problems creatively", "I firmly believe that I can come up with innovative ways to complete work tasks", "I can propose creative solutions with the help of Gen AI", "Even when facing complex problems, I firmly believe that I can explore new ideas with the assistance of Gen AI", etc. The test items are scored using the Likert five-point scoring method. The higher the score, the stronger the sense of creativity and self-efficacy. In this study, the Cronbach's α coefficient of the scale was 0.866 and the KMO coefficient was 0.917, which fully demonstrated that the scale had good reliability and validity.

Data Analysis

Firstly, the Harman single-factor test method is adopted to detect the common method deviation problem. Secondly, descriptive

statistics and Pearson correlation analysis were conducted for the variables. Secondly, by means of the Structural Equation Model (SEM), the predictive effect of Gen AI on the creative problem-solving ability of college students is explored. Meanwhile, the Bootstrap method is used to verify the mediating role of creativity self-efficacy between Gen AI and creative problem-solving ability. Finally, based on theoretical assumptions, build and verify the relationship model among Gen AI, creative self-efficacy and creative problem-solving ability.

Results

Common Method Bias Test

To examine the possible common method bias in the questionnaire data, this study applied Harman's single factor test to analyze all items of the three variables and determined according to the rules: When the proportion of variance explained by the first common factor without rotation does not exceed the critical value of 40%, it can be determined that the homologous variance problem in the sample is within the acceptable range. Through specific analysis, it is concluded that the variance explained by the first unrotated common factor is 34.833%, which exactly reaches the edge below the specified limit value. Ultimately, it was determined that the common method bias phenomenon was not sufficient to have a substantial impact on our conclusion, thereby ensuring that the result was accurate and reliable.

Correlation analysis and descriptive statistics among various variables

Table 1 shows the mean, standard deviation and pairwise correlation of each major variable in this study. The application of Gen AI is positively correlated with creative problem-solving ability (r=0.706, P<0.01) and creative self-efficacy (r=0.706, P<0.01). The ability to solve creative problems is the main factor influencing the creative self-efficacy There is a significant correlation between the two variables (r=0.734, P<0.01), which can be used for further hypothesis testing.

Table 1: Means, standard deviations and correlation coefficients of the Main Variables (N=373).

Variables	Means ± standard deviations	1.The application of Gen AI	2.Creative problem-solving ability	3.Creativity Self-efficacy
1.The application of Gen AI	3.92±0.60	1		
2.Creative problem-solving ability	3.81±0.68	0.533***	1	
3.Creativity Self-efficacy	3.82±0.65	0.605***	0.788***	1
Note: *** indicates $P < 0.001$				
Mediating Effect Test				

Mediating Effect Test

Relevant analysis indicates that there is a significant correlation among the application of Gen AI, college students' creative problem-solving ability, and their self-efficacy in creativity, which lays an empirical foundation for subsequent in-depth analysis. This study adopted the mediating effect test method proposed by Hayes, taking the use of Gen AI as the independent variable, academic achievement as the dependent variable, and academic self-efficacy as the mediating variable, to verify the possible mediating effects. By applying Model4 in the SPSS macro program PROCESS developed by Hayes and combining it with the biasis-corrected non-parametric percentile Bootstrap method, 50,000 repeated samples were conducted to calculate the 95% confidence interval. If the confidence interval corresponding to a certain path does not contain 0, it indicates that the mediating effect of this path is statistically significant.

It was found that Gen AI applications could significantly and positively predict creativity self-efficacy (β=0.605, t=19.007, P<0.001), and both generative artificial intelligence applications and creativity self-efficacy could significantly and positively predict college students' creative problem-solving ability (β=0.088, t=8.095, P<0.05; β=0.735, t=10.115, P<0.001)

Table 2: Regression analysis of the relationships between variables in the mediation Model.

Regression equation		Overall fitting index			Significance of the regression coefficient	
Result variable	Predictor variable	R	R^2	F	β	t
Creativity Self-efficacy	The application of Gen AI	0.605	0.367	214.699	0.605	14.653***
Creative problem-solving ability	The application of Gen AI	0.791	0.626	309.374	0.088	2.201*
Creativity Self-efficacy					0.735	18.387***
Note: * indicates P <0.05, and *** indicates P <0.001						

In this study, the deviation-corrected percentile Bootstrap method was used to test the mediating effect. The relevant analysis results are detailed in Table 3. It can be seen from the results that both the mediating effect and the direct effect have reached significant levels, which indicates that the mediating model is valid. After calculation, the proportion of mediating effect is 83.48%. This data indicates that creativity self-efficacy shows partial mediating characteristics in the mediating model. From this, it can be inferred that the impact of Gen AI applications on college students' creative problem-solving abilities is multi-dimensional. It can not only directly affect college students' creative problem-solving abilities but also, through the intermediate variable of creativity self-efficacy, have an indirect impact on college students' generative problem-solving abilities.

Table 3: It shows the mediating effect of creativity self-efficacy in the impact of Gen AI applications on college students' creative problem-solving abilities.

Path	Mediating effect value	Bootstrap SE	Boot CI Lower	Boot CI Upper	Effect proportion
Mediating effect	0.5044	0.0530	0.3938	0.6012	83.48%
Direct effect	0.0997	0.0453	0.0106	0.1888	16.52%
Total effect	0.6042	0.0498	0.5062	0.7021	

Discussion and Suggestions

Discussion

Through empirical research, the conclusion is drawn that the use of artificial intelligence has a significant positive predictive effect on college students' creative problem-solving ability, and creativity self-efficacy plays a mediating role in it.

Relevant analysis shows that the use of artificial intelligence-assisted innovation tools by college students is positively correlated with their creative problem-solving abilities. That is, in the process of learning and project practice, students who make use of artificial intelligence-assisted innovation tools (such as intelligent creative generation software, data analysis and simulation tools, etc.) show more prominent creative problem-solving abilities. This indicates that the impact of artificial intelligence-assisted innovation on college students' creative problem-solving abilities is positive and stable, which is in line with the research viewpoints of predecessors in the field of innovation education [11].

On the one hand, the frequency of using artificial intelligence-assisted innovation tools is positively correlated with students' self-efficacy in creativity. The more times students carry out innovative activities with the help of artificial intelligence, the stronger their sense of creative self-efficacy will be. This phenomenon confirms the hypothesis made in this research. Carrying out innovative activities with the help of artificial intelligence can provide students with richer and more diverse information resources and innovative ideas. For instance, intelligent creative generation software can quickly offer a variety of creative solutions, helping students break through traditional thinking patterns and broaden their innovative horizons. During this process, students constantly gain experiences of success, become more confident in their innovative abilities, and thus develop a strong sense of creative self-efficacy. On the other hand, from the perspective of the relationship between creative self-efficacy and creative problem-solving ability, there is a very strong correlation between the two.

Students with a high sense of self-efficacy in creativity are more willing to try new methods and ideas when facing creative problems, and are brave enough to challenge difficulties, demonstrating stronger abilities to solve creative problems. Of course, some studies have pointed out that the improvement of creative problem-solving ability is influenced and affected by factors such as the external environment and teamwork, rather than entirely coming from an individual's own strength [15]. However, through its own empirical research, this paper points out that the key influencing college students' creative problem-solving ability lies in the existence of creative self-efficacy. Without a certain sense of creative self-efficacy, students will find it difficult to maintain a positive attitude and firm confidence when facing complex creative problems. External motivating factors (such as team support, external rewards, etc.) may need to be based on an individual's sense of creative self-efficacy to function better.

The results of the mediating effect test indicate that in the process of the influence of artificial intelligence-assisted innovation on college students' creative problem-solving ability, there exists a mediating role of creativity self-efficacy. This result also confirms the previously proposed hypothesis, that is, the mechanism by which college students' application of artificial intelligence-assisted innovation affects their creative problem-solving ability: on the one hand, artificial intelligence directly provides college students with powerful technical support and rich information resources, which helps them broaden their thinking and gain inspiration, thereby enhancing their creative problem-solving ability; On the other hand, it is to enhance students' self-efficacy in creativity, thereby promoting the improvement of their creative problem-solving abilities. This might be due to the fact that each student has different ways of innovative thinking and acceptance abilities. Artificial intelligence provides personalized innovation assistance in an intelligent way, which can specifically meet the diverse needs of students, thereby enhancing their innovation efficiency and capabilities.

For instance, for some students who have difficulties in creative conception, intelligent creative generation software can quickly

generate multiple creative directions based on the keywords they input, helping them broaden their thinking. For students who are weak in data analysis, data analysis tools can provide intuitive charts and in-depth analysis results, enhancing their understanding and problem-solving abilities. With the assistance of artificial intelligence, these students can carry out innovative activities more effectively, thereby enhancing their sense of creativity and self-efficacy. Another reason is that when evaluating college students' creative problem-solving abilities, it is mostly based on their performance in innovative projects and competition activities, and many evaluations are one-off [1]. Many students often fail to fully demonstrate their actual capabilities when facing important innovation evaluations due to reasons such as nervousness and lack of confidence. This psychological state reduces the extent to which they transform their innovative potential into actual creative problem-solving abilities [12].

Therefore, it is of vital importance to strengthen the cultivation of college students' self-efficacy in creativity. By rationally using artificial intelligence-assisted innovation tools, enhancing students' self-efficacy in creativity can help them be more composed and confident when facing creative problems, fully exerting their innovative capabilities, and thereby improving their ability to solve creative problems.

Suggestions

To effectively enhance college students' creative problem-solving abilities, help them stand out in the future society and workplace, and promote the continuous optimization and upgrading of higher education in the cultivation of innovative talents, this study, based on the theme of "How Artificial Intelligence Affects College Students' creative Problem-solving Abilities: The Mediating Role of Creativity Self-efficacy", puts forward the following specific suggestions:

The wide promotion of artificial intelligence-assisted innovation tools

Colleges and universities should actively promote the popularization and application of artificial intelligence-assisted innovation tools on campus. On the one hand, teachers are encouraged to introduce these tools in various innovative courses and project guidance. For instance, in product design courses, students are guided to use intelligent design software for creative conception and model construction. In scientific research projects, artificial intelligence tools for data analysis are utilized to assist students in handling complex data and uncovering potential patterns. To ensure that teachers can skillfully apply these tools and effectively integrate them into teaching, schools can organize specialized training courses, workshops and academic symposiums, inviting industry experts and technicians to share the latest applications of artificial intelligence in the field of innovation and educational practical experiences. On the other hand, schools should provide students with all-round technical support and usage guidance.

A student innovation technology service center can be established, equipped with professional technicians to answer students' questions they encounter when using artificial intelligence-assisted innovation tools. The organization established student innovation mutual assistance groups, allowing students with better technical skills to help other classmates, creating a good learning atmosphere and ensuring that every student can proficiently master and apply these tools to carry out innovation activities.

In-depth cultivation of creative self-efficacy

Given that creativity self-efficacy plays a significant mediating role in the process in which artificial intelligence influences college students' creative problem-solving abilities, colleges and universities need to attach great importance to and strengthen the cultivation of students' creativity self-efficacy. First of all, offer specialized creativity cultivation courses and lectures to systematically impart theoretical knowledge and practical methods of creativity to students. The course content can include innovative thinking training, creative stimulation techniques, problem-solving strategies, etc. Through various teaching methods such as case analysis, group discussion, and practical operation, it guides students to recognize their creative potential and establish a positive creative attitude. Secondly, teach students to set reasonable, challenging and achievable goals. In innovative activities, help students break down big goals into small ones, allowing them to experience the joy of success in the process of gradually achieving these small goals, thereby enhancing their self-confidence and self-efficacy.

At the same time, guide students to correctly deal with setbacks and failures in the process of innovation, cultivate their optimistic and tenacious mindset, and view setbacks as opportunities for growth and learning rather than reasons to deny themselves. In addition, a wide variety of innovation competitions and academic work creation activities are held to provide students with a platform to showcase their talents and creativity. By participating in these activities, students can not only exercise their creative problem-solving abilities, but also discover their own strengths and weaknesses in communication and competition with other classmates, further enhancing their sense of self-efficacy. Schools can offer appropriate rewards and recognition to students who perform outstandingly in activities to stimulate the innovative enthusiasm of more students.

Construction of a diversified innovation evaluation system

The traditional single evaluation method often focuses on the final outcome, making it difficult to comprehensively and accurately reflect students' efforts and progress in the innovation process, and is also not conducive to the cultivation of students' creativity and self-efficacy. Therefore, colleges and universities should establish a diversified innovation evaluation system. In terms of evaluation content, apart from focusing on students' innovative works and achievements, it is also necessary to comprehensively consider their performance during the innovation process, such as the development of innovative thinking, teamwork ability, and the improvement of problem-solving skills. For instance, when evaluating an innovative project, one can examine how students conceive their ideas in the early stage of the project, how they communicate and collaborate with team members during the project execution, and what solutions they take when encountering difficulties, etc. In terms of evaluation methods, a combination of

process evaluation and summative evaluation is adopted.

Process evaluation can be conducted through methods such as classroom performance records, project progress reports, and group mutual evaluations, providing timely feedback on students' performance during the innovation process. This enables students to understand their strengths and weaknesses, allowing them to make timely adjustments and improvements. Summative assessment is conducted after students have completed innovative projects or courses, comprehensively evaluating their overall performance. In addition, a combination of self-assessment by students and evaluation by teachers can be introduced, allowing students to reflect on and summarize their innovative processes and achievements, while also listening to the professional opinions and suggestions of teachers.

Establishment of a collaborative education mechanism involving families, schools and communities

Families, schools and society all play important roles in students' growth. To cultivate students' creative problem-solving abilities and self-efficacy in creativity, it is necessary for the three to form a collaborative and joint force. Schools should enhance communication and cooperation with families, regularly organize parent-teacher meetings, parent open days and other activities, introduce to parents the measures and achievements of the school in cultivating students' innovative ability, creativity and self-efficacy, and at the same time understand students' performance and needs at home. For some parents who have less knowledge about artificial intelligence and innovative education, schools can offer specialized parent training courses to help them recognize the significance of artificial intelligence in innovative education and how to support their children's innovative activities in a family environment. In addition, schools should also actively connect with social resources, establish cooperative relationships with enterprises, research institutions, etc., and provide students with more practical opportunities and innovation platforms. For instance, organizing students to visit enterprise innovation studios and participate in scientific research projects of research institutions enables them to get in touch with the actual production and research environment, understand the latest trends and demands of the industry, and broaden their innovative horizons. Meanwhile, enterprise experts and scientific researchers are invited to the school to hold lectures and guide students' innovative projects, providing professional advice and guidance to students.

Conflict of Interest

On behalf of all authors, the corresponding author states that there is no conflict of interest. This work has been conducted with no financial or non-financial interests that could be seen as influencing the content submitted.

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Conceptualization and supervision, YL; validation and formal analysis, YL, YW, LR, YH.

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