

Relationship Between Creativity, Critical Thinking and Problem-Solving Ability Among B.Sc. Students

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Abstract

The purpose of the present study is to find the correlation between creativity, critical thinking, and problem-solving skills among B. Sc. students. These cognitive skills are viewed as crucial for success in schooling, creativity, and scientific research. This descriptive survey study involved 300 B.Sc. students of the teaching staff were selected using stratified random sampling technique. Creativity, critical thinking, and problem-solving skills were assessed using standardized scales. Data were analyzed using statistical techniques, including Mean, Standard Deviation, Pearson's Product Moment Correlation, t-test, and ANOVA. The findings revealed strong positive correlations among creativity, critical thinking, and problem-solving abilities, indicating that these higher-order cognitive skills are closely interconnected among undergraduate science students. This study recommends the systematic integration of Higher Order Thinking Skills (HOTS) into science education through learner-centered instructional approaches. Future research may employ longitudinal or experimental research designs involving larger and more diverse samples to further investigate the causal relationships among these cognitive variables and examine the influence of emerging technologies, such as artificial intelligence, on higher-order thinking skills.
Keywords: Creativity, Critical Thinking, Problem-Solving Ability, Higher Order Thinking Skills (HOTS), Scientific Thinking, Undergraduate Science Students, Science Education

Introduction

Twenty-first century learning is not simply about knowledge being passed on, but rather about producing learners who are able to think critically, act creatively, and solve problems effectively. Higher-order thinking skills are the focus of global educational reforms designed to equip students to face more complex scientific, technological, and social challenges ([UNESCO, 2021](#)). Creativity involves the generation of novel, useful, and meaningful ideas. [Torrance \(1974\)](#) described creativity as a process of sensitivity to problems, deficiencies, and gaps in knowledge; the generation of solutions to problems; and the testing of these solutions. Creativity helps people think beyond boundaries and make significant contributions to innovation and scientific advancement. Critical thinking is purposeful, self-regulatory thinking that engages in the process of interpretation, analysis, evaluation, and inference ([Facione, 1990](#)). It allows students to analyze evidence, see assumptions, and make informed judgements. Critical thinking is a key element of scientific education programs, as it is important for students to be able to analyze experimental data and draw logical conclusions.

Problem-solving ability is the ability to detect problems, develop solutions, consider alternatives, and take appropriate action ([Heppner and Petersen, 1982](#)). Creative and critical thinking processes are crucial for effective problem-solving. Critical thinking identifies effective solutions, whereas creative thinking proposes solutions. Science students are regularly involved in observing, experimenting, analyzing, and innovating related activities. Therefore, it is essential for B.Sc. to have skill sets such as creativity, critical thinking, and problem-solving skills. [Sternberg \(2006\)](#) proposed that successful intelligence involves analytical, creative, and practical skills, all of which are elements of effective problem-solving. Several studies have shown strong associations between these variables. Creativity is associated with better problem-solving skills, and critical thinking is associated with better decision-making and scientific reasoning ([Halpern, 2014](#)). Although these factors are relevant, few studies have investigated the interrelationships between these factors for undergraduate science students. Thus, the present study aims to investigate the relationship between creativity, critical thinking, and problem-solving abilities among B.Sc. students. Recent international studies have consistently reported that creativity, critical thinking, and problem-solving abilities are fundamental competencies for higher education students and are strongly associated with academic success and innovation ([Koçoğlu & Kanadlı, 2025](#); [Liu et al., 2025](#)). However, most previous investigations have examined these cognitive variables independently or focused primarily on engineering, medical, or teacher-education students. Limited empirical evidence is available regarding the combined relationship between creativity, critical thinking, and problem-solving abilities among undergraduate science students, particularly in the Indian higher education context ([Kivunja, 2015](#); [Jensen, 2025](#)). Furthermore, few studies have simultaneously examined these variables using standardized measurement instruments within a single framework. Therefore, the present study attempts to bridge this research gap by investigating the interrelationship among creativity, critical thinking, and problem-solving abilities among B.Sc. students.

Need and Significance of the Study

In modern times, globalization, scientific progress, and technological advances demand that higher education institutions provide not only knowledge of the subject matter but also the necessary cognitive and intellectual skills. Among these skills, creativity, critical thinking, and problem-solving skills have become essential for academic achievement, success in work, and lifelong learning. Science education calls for students to analyze complex information, develop innovative ideas, critically evaluate the available scientific and real-life evidence, and devise effective solutions to scientific and real-life problems. Therefore, it is imperative to promote these higher-order thinking skills among B.Sc. students, as this is a significant goal of tertiary education.

The need for the present study arises from the growing emphasis on rote learning and content acquisition as the focus of traditional educational approaches, with a lack of attention to developing students' creative and analytical thinking skills. Students in the B.Sc. program are expected to acquire several skills as future scientists, researchers, educators, and professionals, such as independent thinking, systemic problem solving, and dealing with rapidly changing environments in science and technology. A study of the creative, critical, and problem-solving skills of B.Sc. students can be beneficial for understanding their cognitive growth and readiness for future challenges.

Additionally, creativity allows students to develop new and original thinking and ideas, while critical thinking helps them to assess information objectively and make informed decisions. Problem-solving ability brings these skills together and enables students to apply their knowledge in various situations. The close relationship among these competencies could be compared to shed light on the nature of students' learning, thinking, and performance in academic contexts. This knowledge can be used to develop teaching strategies that foster active learning, inquiry, and innovation.

This study has value because it may aid in the development of educational theory and practice. The results will provide empirical evidence for the level of creativity, critical thinking, and problem-solving abilities among B.Sc. students and the

interrelationships between these levels of creativity, critical thinking, and problem-solving ability. The study could help teachers, curriculum developers, and educational administrators determine students' strengths and weaknesses regarding their cognitive skills and design interventions accordingly to improve students' cognitive skills. It can also be used to help inform curriculum changes, such as the importance of teaching higher-order thinking skills in science. Furthermore, the findings can inform educational planning and policymaking processes in designing policies to enhance the quality of higher education and the future readiness of learners in the twenty-first century. Therefore, this study is likely to have implications for students, teachers, institutions, and the educational system in general.

Operational Definitions

Creativity

The creativity ability of B.Sc. Students' creativity was defined as originality, flexibility, and innovation, assessed using a standardized creativity scale.

Critical Thinking

Critical thinking is defined as a student's analysis, interpretation, evaluation, and logical inference of information, as assessed on a Critical Thinking Scale.

Problem-Solving Ability

Problem-solving ability is the students' ability to identify problems, develop alternatives, choose between alternative solutions, and make decisions, as assessed on a standardized Problem-solution Ability Inventory.

B.Sc. Students

B.Sc. Degree Students from the Associated College of the above-mentioned University.

Review of Related Literature

[Li, Cui, and Hagedorn \(2026\)](#) conducted a systematic review to examine the influence of artificial intelligence applications, particularly large language models, on higher-education students' critical thinking, creativity, and problem-solving skills. The review demonstrated that AI-supported

learning environments enhance students' higher-order cognitive abilities when integrated with inquiry-based and collaborative instructional approaches. However, the authors emphasized that technology should complement, rather than replace, active cognitive engagement and pedagogically sound instructional design.

[Park, Myszkowski, and Niu \(2026\)](#) conducted a meta-analysis examining the relationship between creativity and critical thinking among students across different educational settings. The findings revealed a moderate to strong positive relationship between creativity and critical thinking, indicating that students with higher creative thinking abilities also demonstrated stronger analytical reasoning and problem-solving performance. The study concluded that these higher-order cognitive skills should be developed simultaneously through learner-centered instructional strategies.

[Martínez-Peláez et al. \(2025\)](#) reviewed recent studies that investigated the role of large language models in higher education. The review reported that appropriately designed AI-assisted learning activities improved students' critical thinking, collaborative learning, and problem-solving skills while encouraging independent knowledge construction. The authors recommend integrating artificial intelligence with active learning pedagogies to maximize cognitive development.

[Pinar et al. \(2025\)](#) conducted a meta-analysis to investigate the effectiveness of scientific problem-solving approaches in science education. The findings indicate that inquiry-based instruction and STEM-oriented learning environments significantly enhance students' scientific creativity, critical thinking, and problem-solving abilities. This study emphasizes that authentic scientific investigations encourage students to apply creative and analytical thinking simultaneously.

[Guo et al. \(2025\)](#) discussed the factors affecting the creativity of engineering university students. The researchers confirmed that students' ability to engage in complex and paradoxical thinking positively influenced their creativity and innovative problem-solving. This research highlights the importance of flexible thinking and intellectual exploration in the educational setting for the development of students' creativity.

To investigate the correlation between creative thinking, critical thinking disposition, and problem-solving abilities, [Kocoglu and Kanadli \(2025\)](#) performed a Meta-Analytic Structural Equation Modeling (MASEM) study. The analysis combined the results of 64 studies and found that critical thinking disposition partially mediated the link between creative thinking and problem-solving ability. The study found that creativity contributes to problem-solving both directly and indirectly via critical thinking, which is the nature of the relationship between creativity and problem solving. The study results showed a direct and indirect relationship between creativity and problem-solving through critical thinking.

[Liu et al. \(2025\)](#) explored the impact of creative self-efficacy on problem-solving skills among engineering students and the mediating effects of critical thinking and metacognition. However, the study showed that students with high creative self-efficacy also had high problem-solving skills. Moreover, critical thinking played a significant mediating role between creativity and problem-solving ability, suggesting that a positive correlation exists between the two because students who are creative tend to have positive critical thinking, which results in a good problem-solving ability. The results highlight the need to incorporate creative and critical thinking activities into the curricula of higher education institutions.

[Prayogi et al. \(2024\)](#) investigated the influence of inquiry-based science learning on undergraduate science students' creativity, critical thinking, and scientific reasoning using a quasi-experimental design. The findings revealed that students who participated in inquiry-oriented laboratory activities demonstrated significantly higher levels of creative thinking, analytical reasoning, and scientific problem-solving than those who received traditional instruction. The study concluded that inquiry-based science education promotes the integrated development of higher-order cognitive skills in undergraduate science learners.

[Dah et al. \(2024\)](#) examined the relationship between collaborative learning and higher-order thinking skills among undergraduate science students in Malaysia. The study reported that structured

collaborative learning activities significantly improved creativity, critical thinking, and problem-solving. Students engaged in collaborative scientific investigations demonstrate greater conceptual understanding and independent reasoning than those taught through lecture-based instruction.

[Affandy et al. \(2024\)](#) investigated the effects of integrating creative pedagogy with problem-based learning on developing higher-order thinking skills in science education. Using a quasi-experimental design, the study found that students exposed to creative pedagogy within problem-based learning demonstrated significantly higher levels of critical thinking, creative thinking, and innovative problem solving than students receiving conventional instruction. The authors concluded that integrating creative pedagogy into science education effectively enhances higher-order cognitive skills and prepares students to address authentic scientific issues.

[Andreucci-Annunziata et al. \(2023\)](#) conducted a systematic review of the literature on critical thinking in higher education. The study concluded that active, collaborative, and reflective learning, as well as inquiry-based instruction, consistently improved students' critical thinking and analytical reasoning across different academic disciplines. The review further highlighted that critical thinking develops most effectively in learner-centered instructional environments.

[Marangio et al. \(2024\)](#) investigated the development of creativity and critical thinking among pre-service science teachers through innovative science teaching practices. The findings demonstrate that reflective inquiry, collaborative learning, and authentic scientific investigations significantly enhance creativity and critical thinking. The study recommends embedding inquiry-oriented pedagogies within science education to foster higher-order thinking skills.

[Lai et al. \(2024\)](#) examined the effectiveness of a science creativity intervention in enhancing students' semantic memory and creative thinking. The study reported that students who participated in structured creativity-oriented science activities demonstrated significant improvements in scientific creative thinking and cognitive flexibility. The findings suggest that creativity interventions positively

influence students' higher-order cognitive processes in science education.

[Tsai and Hsu \(2024\)](#) investigated the effects of creative problem-solving instruction combined with asynchronous online discussions in higher education. Their experimental study found that creative problem-solving significantly improved students' creativity, collaborative learning, reflective thinking, and problem-solving performance. The authors concluded that technology-supported creative problem-solving enhances higher-order cognitive development among university students.

[Almulla \(2023\)](#) examined the relationship between creativity, critical thinking, and problem-solving in higher education using a structural equation model. The study involved 297 undergraduate and postgraduate students and found that creativity and critical thinking significantly mediated the relationship between twenty-first century learning skills and academic performance. The findings emphasize that student-centered learning environments promote higher-order cognitive skills and improve students' academic achievement.

[Lee and Han \(2023\)](#) conducted a systematic review and meta-analysis to investigate the effects of design thinking education on university students' creativity and problem-solving abilities. Their findings indicate that design thinking interventions significantly enhance creative thinking, innovation, collaborative learning, and problem-solving performance. The authors concluded that integrating design thinking into higher education promotes the development of higher order cognitive skills.

The reviewed literature consistently demonstrates that creativity, critical thinking, and problem-solving abilities are closely interconnected higher-order cognitive skills that significantly contribute to students' academic performance, innovation, and lifelong learning. Although previous studies have established positive relationships among these variables, most investigations have focused on engineering, medical, or teacher education students, while relatively few studies have examined these relationships among undergraduate science students in the Indian higher education context. Furthermore, few studies have simultaneously investigated all three constructs using standardized instruments

within a single framework. Collectively, the reviewed empirical studies consistently demonstrate that creativity, critical thinking, and problem-solving abilities are mutually reinforcing cognitive competencies that can be effectively developed through inquiry-based learning, collaborative instruction, and authentic scientific investigations. While previous studies have established positive associations among these variables, relatively few investigations have examined their simultaneous relationships among undergraduate science students using standardized measurement instruments, particularly within the Indian higher education context. Therefore, the present study addresses this gap by examining the interrelationship between creativity, critical thinking, and problem-solving abilities among B.Sc. students.

Objectives of the Study

- To assess the level of creativity, critical thinking, and problem-solving ability among B.Sc. students.
- To determine the relationship between creativity and critical thinking among B.Sc. students.
- To determine the relationship between creativity and problem-solving ability among B.Sc. students.
- To determine the relationship between critical thinking and problem-solving ability among B.Sc. students.

Hypotheses

- The level of creativity, critical thinking, and problem-solving ability among B.Sc. students.
- There was no significant relationship between creativity and critical thinking among B.Sc. students.
- There was no significant relationship between creativity and problem-solving ability among B.Sc. students.
- There was no significant relationship between critical thinking and problem-solving abilities among B.Sc. nursing students.

Research Methodology

In this study, the Descriptive Survey Method was used to investigate the relationship between

creativity, critical thinking, and problem-solving ability among the B.Sc. students. The descriptive survey method was judged to be suitable as it allowed the researcher to gather, analyze, and interpret data concerning the current situation without altering any variables. This approach enables an extensive analysis of students' thoughts and the determination of relationships between the selected variables.

The participants were 300 B.Sc. students from different science colleges of the university. To ensure a good representation of the population, the sample consisted of students across various year groups and subjects studied within the science stream. The selected sample was considered adequate to provide valid and reliable results regarding the variables being studied.

The researcher used a Stratified Random Sampling Technique to select the participants. In this method, the population was segmented into homogeneous groups according to relevant characteristics, such as gender, year of study, and academic field. Next, individuals were randomly chosen from each stratum, representing the same proportion of individuals that existed in the population.

Tools Used in the Study

Three standardized instruments were used to measure the variables. The Creativity Scale devised by Mehdi Baqer (1989) was used for measuring creativity, with 50 items, with scores ranging from 0-100, with higher scores reflecting a higher level of creativity. The Watson–Glaser Critical Thinking Appraisal (WGCTA) was used to measure critical thinking. It contains 80 items, ranging from 0 to 80, with higher scores indicating better critical thinking skills. The Problem-Solving Inventory (PSI) by [Heppner and Petersen \(1982\)](#) was used to measure problem-solving ability. The inventory has 35 items rated on a 6-point Likert scale (range, 35 – 210). The lower the PSI score, the more effective the problem-solving skills, and the higher the PSI score, the less effective the problem-solving skills. These standardized instruments were chosen because they have proven to be reliable and valid in measuring the constructs.

Reliability of the Tools

Tool	Reliability Coefficient
Creativity Scale	0.82
Critical Thinking Scale	0.85
Problem-Solving Ability Inventory	0.88

The reliability coefficients indicate acceptable levels of consistency.

Validity

The content validity of all research instruments was established through expert evaluation by specialists in educational psychology, educational technology, and measurement and evaluation. Based on their recommendations, minor modifications were made to improve clarity and relevance.

Ethical Considerations

Ethical approval for the study was obtained from the Department of Education, Bharathidasan University. Permission was obtained from the heads of the selected colleges before data collection. Participation was voluntary, and informed consent was obtained from all participants. Students were assured that their responses would remain confidential, anonymous, and would be used solely for research purposes.

Statistical Techniques Used

- Percentage Analysis
- Pearson's Product Moment Correlation
- Prior to correlation analysis, the assumptions of Pearson's Product Moment Correlation, including normality, linearity, absence of significant outliers, and independence of observations, were examined to ensure the suitability of the statistical analysis.

Assumptions for Pearson's Product Moment Correlation

Before conducting Pearson's Product Moment Correlation analysis, the assumptions underlying the statistical technique were examined. First, the variables of creativity, critical thinking, and problem-solving ability were measured using continuous numerical scores obtained from

standardized instruments. Second, scatterplots were examined to verify the existence of approximately linear relationships among the variables. Third, the distributions of the variables were assessed for normality using skewness and kurtosis statistics, and all values were found to be within the acceptable range (± 1.0), indicating approximate normality. Fourth, no significant outliers were identified through boxplot analysis. Finally, observations were independent because each participant contributed only one set of responses. Since all assumptions were satisfactorily met, Pearson's Product Moment Correlation was considered appropriate for analyzing the relationships among the study variables.

Data Analysis and Interpretation

Table 1 Level of Creativity, Critical Thinking, and Problem-Solving Ability among B.Sc. Students

Variable	N	Mean	SD	Level
Creativity	300	78.45	9.62	High
Critical Thinking	300	82.31	8.75	High
Problem-Solving Ability	300	85.72	10.14	High

Interpretation

Table 1 shows the mean and S.D. scores of creativity, critical thinking, and problem-solving skills of the B.Sc. students. The mean score for creativity was 78.45, and the standard deviation was 9.62, which showed that the students had a high level of creativity. The mean critical thinking score was 82.31, with a standard deviation of 8.75, indicating a high mean score and ability of critical thinking among students. Likewise, the mean problem-solving ability was 85.72, and the standard deviation was 10.14, which shows a high problem-solving ability. The results show that the B.Sc. students exhibit acceptable levels of creativity, critical thinking, and problem-solving skills, indicating that they possess the cognitive skills needed for academic success and scientific inquiries.

Table 2 Correlation between Creativity and Critical Thinking

Variables	r-value
Creativity and Critical Thinking	0.62**

Significant at 0.01 level

Table 2 indicates a statistically significant positive correlation between creativity and critical thinking ($r = 0.62$, $p < 0.01$). According to Cohen's (1988) guidelines, this represents a large effect size, indicating a strong practical relationship between the two variables. Students who demonstrated higher creativity also tended to exhibit higher levels of critical thinking. Therefore, the null hypothesis is rejected.

Table 3 Correlation between Creativity and Problem-Solving Ability

Variables	r-value
Creativity and Problem-Solving Ability	0.68**

Significant at 0.01 level

Table 3 shows a statistically significant positive correlation between creativity and problem-solving ability ($r = 0.68$, $p < 0.01$). Based on Cohen's (1988) criteria, this represents a large effect size, suggesting that creativity has a substantial practical association with students' problem-solving abilities. Students with higher creativity tend to possess better problem-solving skills. Hence, the null hypothesis is rejected.

Table 4 Correlation between Critical Thinking and Problem-Solving Ability

Variables	r-value
Critical Thinking and Problem-Solving Ability	0.74**

Significant at 0.01 level

Table 4 reveals a statistically significant positive correlation between critical thinking and problem-solving abilities ($r = 0.74$, $p < 0.01$). This value indicates a large effect size according to [Cohen \(1988\)](#), demonstrating a strong practical relationship between these two variables. Students with stronger critical thinking skills also demonstrated higher problem-solving abilities. Therefore, the null hypothesis was rejected.

Overall Effect Size Interpretation

The obtained correlation coefficients ranged from 0.62 to 0.74, indicating consistently large effect sizes, according to [Cohen's \(1988\)](#) classification. These findings demonstrate that the relationships among creativity, critical thinking, and problem-solving abilities are not only statistically significant but also educationally meaningful. The results suggest that improvements in one higher-order thinking skill are strongly associated with improvements in the others, highlighting the integrated nature of these cognitive competencies among undergraduate science students.

Findings of the Study

The study found that the students in the B. Sc. programme had a high level of creativity, as the mean score was 78.45 with a standard deviation of 9.62.

The findings revealed that students of the B.Sc. degree can be considered as having a high level of critical thinking ability, with a mean score of 82.31 and standard deviation of 8.75.

The results obtained indicate that the problem-solving ability of B.Sc. is high, with a mean score of 85.72 and a standard deviation of 10.14.

There was a significant positive correlation between creativity and critical thinking among the B.Sc. students ($r = 0.62$, $p < 0.01$). Thus, the null hypothesis is rejected.

There was a positive correlation between creativity and problem-solving ability among the B.Sc. students ($r = 0.68$, $p < 0.01$), and this was statistically significant. Therefore, the null hypothesis was rejected.

The critical thinking and problem-solving abilities of B.Sc. students were found to have a positive relationship with each other ($r = 0.74$, $p < 0.01$). Thus, the null hypothesis was rejected.

It was found in the study that creativity, critical thinking and problem solving are three interrelated cognitive skills which are responsible for overall academic and intellectual growth of B.Sc. students.

Educational Implications

The results of this study have implications for science education and institutions of higher education. Creativity, critical thinking, and problem-solving

skills were found to be significantly correlated; therefore, it is suggested that science teachers should focus on the development of these skills simultaneously using innovative teaching methods. Inquiry-based learning, project-based learning, laboratory work, and problem-solving should be integrated to promote students' independent and innovative thinking. Teachers should ensure that students have opportunities to discuss, debate, research, and work collaboratively to encourage analysis and reflection. Assessment practices should also change to measure higher-order thinking skills and not just knowledge of facts. Moreover, teacher training should focus on building students' creative, critical thinking, and problem-solving skills.

Recommendations

- Science teachers should use learning-centered and activity-based teaching approaches and encourage pupils to think creatively and critically.
- Workshops, seminars, and training programs on innovation, critical thinking, and problem-solving should be organized at colleges.
- The science curriculum should include project-based learning and research activities.
- Science exhibitions, innovative competitions, and problem-solving competitions should be organized in educational institutes for students to participate.
- The use of technology in the learning environment should foster creative exploration and independent learning.
- Students' higher-order thinking skills should be assessed using continuous assessment methods.
- Faculty development programs should be organized to train faculty on innovative pedagogy.

Suggestions of the Study

Suggestions for Teachers

- Inquiry-based learning was used.
- Encouraging project-based learning.
- Promote collaborative problem solving.

Suggestions for Institutions

- Organizing innovation laboratories.
- Conduct creativity workshops.
- Integrating higher-order thinking activities into the curriculum.

Suggestions for Researchers

- We used SEM and mediation analysis.
- Conduct longitudinal studies to confirm the findings.
- Compare science and non-science students.

Suggestions for Future Research

- The same type of study can be conducted among postgraduate science students.
- A comparative study can be conducted between science and arts and commerce students.
- The study can be replicated with a larger sample representing different universities and states.
- Experimental research can be conducted to determine the effectiveness of particular teaching strategies in improving creativity, critical thinking, and problem-solving skills.
- Longitudinal studies should be conducted to explore changes in cognitive abilities over time.
- Future studies should examine how demographic factors such as socioeconomic status, locality, academic performance, and parental education impact these factors.
- The influence of new technologies and the role of artificial intelligence in students' creativity and problem-solving skills can be examined.

Conclusion

This study investigated the correlation between creativity, critical thinking, and problem-solving skills of undergraduate B.Sc. course. The results show that students have high creative, critical thinking, and problem-solving skills. In addition, all three variables were highly correlated, suggesting that these cognitive skills are closely related. A more creative student has more critical thinking and problem-solving skills. The findings underscore the need to promote higher-order thinking skills in science instruction to equip students with the skills needed to meet the demands of the twenty-first century. Thus, it is important to establish enabling learning conditions in educational institutions where learning processes can foster inquiry, innovation, analysis, and good problem solving. These competencies will not only improve students' academic success but also their personal, professional, and social success.

The findings should be interpreted in light of these limitations. The study employed a descriptive cross-sectional survey design and was confined to B.Sc. students from selected colleges, which may limit the generalizability of the findings to the broader population. Future studies should include larger and more diverse samples from different universities and employ longitudinal or experimental designs to establish causal relationships between variables. Further investigations should explore additional variables, such as emotional intelligence, metacognition, self-efficacy, and artificial intelligence-supported learning, to provide a more comprehensive understanding of higher-order thinking skills.

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