Effect Of Curiosity On Critical Thinking And Achievement In Science Classes

Allyson Joi B. Ranille

Institute of Graduate and Professional Studies, Lyceum-Northwestern University, Dagupan City, Philippines

ABSTRACT

This study investigated how dispositional and situational curiosity were related to critical thinking and achievement in secondary Science classes in the Schools Division Office of Mabalacat City. The research used a quantitative correlational design with predictive, mediation, factorial, and quasi-experimental components. The source manuscript targeted approximately 200-250 learners from intact classes selected through purposive and cluster sampling, although the final analyzed sample was not reported. Dispositional curiosity was measured through the Curiosity and Exploration Inventory-II, state curiosity through a situational scale, critical thinking through the Watson-Glaser Critical Thinking Appraisal, and achievement through summative scores, final grades, and a Science problem-solving task. Dispositional curiosity significantly predicted critical thinking (beta = 0.38, $p < .001$) and explained 14.4% of its variance. Critical thinking partially mediated the relationship between state curiosity and Science achievement, with an indirect effect of 0.10 and a 95% confidence interval of 0.05-0.15. A significant interaction occurred between curiosity level and instructional method ($F = 6.16$, $p = .003$): inquiry-based learning produced the highest grade among high-curiosity learners ($M = 95.2$), while direct instruction was slightly more favorable among low-curiosity learners. Objectively observed question-asking correlated more strongly with problem-solving performance ($r = 0.55$, $p < .001$) than self-reported question-asking ($r = 0.31$, $p = .015$). The results support curiosity-responsive, differentiated Science instruction and explicit teaching of productive question-asking.

Keywords: *curiosity; critical thinking; Science achievement; inquiry-based learning; question-asking; differentiated instruction*

INTRODUCTION

Curiosity drives learners to notice gaps in understanding, seek explanations, and persist with unfamiliar problems. In Science, this motivation is closely aligned with inquiry because learners must question observations, evaluate evidence, and revise explanations. Research cited in the source manuscript connects curiosity with deeper engagement, critical thinking, and continued interest in scientific topics (Kang & Kim, 2024; Williams et al., 2021).

Curiosity alone, however, does not automatically produce disciplined reasoning. Students also need instruction that supports inference, evidence evaluation, problem solving, and reflection. Guided inquiry and student-centered approaches can convert interest into analytical activity, whereas rigid or curiosity-suppressing environments may discourage questioning (Evans et al., 2023; Kirk et al., 2023).

The study examined four related questions: whether dispositional curiosity predicted critical thinking; whether critical thinking mediated the relationship between state curiosity and achievement; whether curiosity interacted with instructional method in predicting final grades; and whether question-asking behavior was associated with Science problem-solving performance.

METHODS

Design, Setting, and Sampling

A quantitative correlational design incorporated predictive regression, mediation analysis, a two-way factorial comparison, and a quasi-experimental instructional-method component. The study was conducted in selected public secondary schools under SDO Mabalacat City over one academic quarter. Two to three schools were purposively selected to represent contrasting instructional approaches, after which intact Science classes were selected through cluster sampling. The source manuscript identified a target of approximately 200-250 learners but did not report the final number included in the analyses.

Measures and Procedure

Dispositional curiosity was measured with the Curiosity and Exploration Inventory-II (CEI-II), while state curiosity was assessed immediately after a Science activity. Critical thinking was measured with the Watson-Glaser Critical

Thinking Appraisal. Trained observers recorded student-initiated questions through a classroom observation checklist. A researcher-developed Science Problem-Solving Task measured the application of scientific knowledge, and a data archival matrix captured summative scores, final grades, and the primary instructional method of each class. Baseline measures were administered at the start of the quarter, observations occurred during selected lessons, state curiosity was assessed after an inquiry activity, and performance outcomes were collected at the end of the quarter.

Statistical Analysis and Ethics

Simple linear regression tested dispositional curiosity as a predictor of critical thinking. Mediation analysis using the PROCESS macro and bootstrapped 95% confidence intervals tested critical thinking as a mediator between state curiosity and achievement. A two-way ANOVA assessed the main and interaction effects of curiosity level and instructional method on final Science grades. Pearson correlation examined the relationship between question-asking and problem-solving performance. The source manuscript reports division and school permissions, parent or guardian consent, student assent, coded data, confidentiality, voluntary participation, and efforts to minimize instructional disruption.

RESULTS AND DISCUSSION

Dispositional Curiosity and Critical Thinking

Table 9. Regression of critical thinking on dispositional curiosity

Predictor	**Standardized beta**	**p-value**	**Variance explained**
CEI-II dispositional curiosity score	0.38	< .001	RZ = 14.4%

Dispositional curiosity was a significant positive predictor of Watson-Glaser performance. Although most variance in critical thinking remained attributable to other factors, a single motivational disposition explaining 14.4% of reasoning scores represents a meaningful contribution. In Science classrooms, curiosity may encourage learners to examine inconsistencies, search for evidence, and remain cognitively engaged with difficult ideas.

Mediating Role of Critical Thinking

Table 10. Reported mediation model for state curiosity, critical thinking, and achievement

Path or effect	Coefficient	Significance / interval
State curiosity -> critical thinking (a)	0.25	$p < .001$
Critical thinking -> achievement (b)	0.40	$p < .001$
Total effect of state curiosity (c)	0.35	$p < .001$
Indirect effect (a x b)	0.10	95% CI [0.05, 0.15]
Direct effect after mediator	0.25	$p < .001$

Critical thinking partially mediated the relationship between momentary curiosity and achievement. The nonzero bootstrap interval supported the indirect pathway, but the remaining direct effect indicated that state curiosity may also improve outcomes through persistence, attention, time on task, or other motivational processes not measured in the model.

Curiosity, Instructional Method, and Final Science Grades

Table 11. Two-way ANOVA results reported in the source manuscript

Effect	F	p-value	Decision
Curiosity level	4.88	.030	Significant
Instructional method	4.70	.012	Significant
Curiosity x instructional method	6.16	.003	Significant

Table 12. Mean final Science grades by curiosity level and instructional method

Curiosity level	Inquiry-based learning	Direct instruction
High curiosity	95.2	87.0
Low curiosity	83.0	84.5

The significant interaction showed that instructional effectiveness depended on learner curiosity. Inquiry-based learning was strongly advantageous for highly curious learners, whereas low-curiosity learners performed slightly better under direct instruction. The findings argue against a uniform instructional prescription. Highly curious learners may benefit from autonomy and open investigation, while learners with lower curiosity may require more explicit structure before gradually moving toward inquiry.

Question-Asking and Problem Solving

Table 13. Correlations of question-asking measures with problem-solving performance

Question-asking measure	Correlation	p-value	Interpretation
Objective classroom observation tally	r = 0.55	< .001	Strong positive
Student self-report	r = 0.31	.015	Moderate positive

Observed question-asking was a substantially stronger correlate of problem-solving than learners' self-reports. This difference suggests that actual information-seeking behavior is a more useful indicator of curiosity in action than students' perceptions of how frequently they ask questions. Teachers may therefore assess engagement through observable questioning and explicitly teach learners how to formulate questions that advance inquiry.

CONCLUSION AND RECOMMENDATIONS

Curiosity was linked to critical thinking and Science achievement through both cognitive and motivational pathways. Critical thinking explained part of the relationship between state curiosity and achievement, instructional method interacted with learner curiosity, and objectively observed question-asking was strongly associated with problem-solving. These results support differentiated Science instruction that deliberately stimulates curiosity while providing the level of structure appropriate to learners' dispositions.

Science teachers may use discrepant events, puzzles, real-world problems, and inquiry prompts to activate state curiosity.

Learners may be taught to generate investigable, evidence-seeking questions, with classroom observation used to monitor actual questioning behavior.

Inquiry-based learning may be emphasized for highly curious learners, while lower-curiosity learners may first receive explicit guidance and gradually increasing autonomy.

Future reports should state the final analyzed sample, participant characteristics, reliability values, full ANOVA degrees of freedom and effect sizes, and detailed mediation output.

Future studies may test the proposed differentiated approach through a clearly defined intervention and longitudinal follow-up.

REFERENCES

Bjerknes, A.-L., Wilhelmsen, T., & Foyn-Bruun, E. (2024). A systematic review of curiosity and wonder in natural science and early childhood education research. Journal of Research in Childhood Education, 38(1), 50-65. https://doi.org/10.1080/02568543.2023.2192249

Evans, N. S., Burke, R. A., Vitiello, V., Zumbrunn, S., & Jirout, J. J. (2023). Curiosity in classrooms: An examination of curiosity promotion and suppression in preschool math and science classrooms. Thinking Skills and Creativity, 49, 101333.

García-Carmona, A. (2025). Scientific thinking and critical thinking in science education: Two distinct but symbiotically related intellectual processes. Science & Education, 34(1), 227-245. https://doi.org/10.1007/s11191-023-00460-5

Gunckel, K. L. (2019). Repairing elementary school science. Theory Into Practice, 58(1), 71-79. https://doi.org/10.1080/00405841.2018.1536918

Kang, J., & Kim, J. (2024). Exploring the predictiveness of curiosity and interest in science learning in and after class. Journal of Research in Science Teaching, 61(8), 1821-1857. https://doi.org/10.1002/tea.21920

Karadeniz, E., & Degirmencay, S. A. (2020). The effect of science-fiction books on arousing curiosity about science in secondary school students. Journal of Turkish Science Education, 17(2), 225-241.

Kirk, M., Tytler, R., & White, P. (2023). Critical thinking in primary science through a guided inquiry pedagogy: A semiotic perspective. Teachers and Teaching: Theory and Practice, 29(6), 615-637. https://doi.org/10.1080/13540602.2023.2191181

Kolstø, S. D., Paulsen, V. H., & Mestad, I. (2024). Critical thinking in the making: Students' critical thinking practices in a multifaceted SSI project. Cultural Studies of Science Education, 19(4), 499-530. https://doi.org/10.1007/s11422-024-10217-3

Lansangan, R. V., & Orleans, A. V. (2024). Exploring Filipino students' critical thinking skills: Basis for enhancement of science laboratory class delivery. Science Education International, 35(3), 281-290.

Lindholm, M. (2018). Promoting curiosity? Possibilities and pitfalls in science education. Science & Education, 27(9-10), 987-1002. https://doi.org/10.1007/s11191-018-0015-7

Luxton, K., & Pritchard, B. (2024). Improving primary science: Guidance report. Education Endowment Foundation.

Özkan, G., & Topsakal, U. U. (2020). The impact of nature education on Turkish students' affective tendencies towards the environment and scientific curiosity. Journal of Curriculum and Teaching, 9(2), 95-101.

Rees, C., Allen, H., Whitehouse, M., Cheeptham, N., Harrison, M., DeVries, E., Sjokvist, G., & Miller, C. (2023). Curiosity-driven, inquiry-based science projects bridge face-to-face and online learning formats during COVID-19: A teacher's community of inquiry. Canadian Journal of Action Research, 23(3), 27-57.

Silva, J., Edmond, J., & Jauregui, C. (2025). Critical thinking in the classroom: Faculty perspectives and practices. Journal of Education and Learning, 14(3), 1-20.

Singh, C. B. P. (2021). Fostering epistemic curiosity in school children by instructional teaching design: Classroom realities of Indian schools. Issues and Ideas in Education, 9(2), 103-112.

Taheri, E., Shareh, H., & Hasanvand, F. (2024). The effect of images and attitudes towards curiosity on depression, anxiety, and fear of consequences of academic success in elementary students: The mediating role of critical thinking. European Journal of Psychology of Education, 39(3), 2991-3010. https://doi.org/10.1007/s10212-024-00854-1

Varlik, S. (2024). Critical and creative thinking in science teachers: The moderating role of epistemology. Journal of Baltic Science Education, 23(5), 964-978.

Williams, A. J., Danovitch, J. H., & Mills, C. M. (2021). Exploring sources of individual differences in children's interest in science. Mind, Brain, and Education, 15(1), 67-76. https://doi.org/10.1111/mbe.12263

Zhu, L., Shu, L., Tian, P., Sun, D., & Luo, M. (2025). Facilitating students' design thinking skills in science class: An exploratory study. International Journal of Science Education, 47(1), 23-44. https://doi.org/10.1080/09500693.2024.2309658