Journal of Science Education
Volume 6, Issue,1, 2024. 53–70

Critical Thinking Skills through Science Learning

Zoha Khan*
Sadaf Zamir Ahmed**

Abstract

Critical thinking skills is a key skill of 21st century skills and has significant value in educational research and practice. The objective of this study was to examine the status of elementary level science students studying in public and private institutions located in Islamabad Capital Territory on critical thinking skills. A descriptive research design was used where a critical thinking skill test was employed to collect the data. Tool was validated through expert pinion and reliability of all three constructs of critical thinking was found to be 0.977, 0.852 & 0.717 which was acceptable. It was found that there was more focus on memorization rather than critical thinking skills among the elementary level students. The test results revealed that the decision-making power, reasoning and problem solving skills were not up to the level. Hence there is need to enhance critical thinking skills among elementary school science students. The curriculum implementation level may be strengthen by involvement of stakeholders. This study may contribute to the development of critical thinking skills among future generations equipped with the cognitive abilities deprecative for reasoning, decision making and problem-solving skills.

Keywords: Critical Thinking, Science learning, Elementary level science students.

---

* M.Phil. Education Scholar Department Humanities, Education & Psychology. Air University, Islamabad. 211601@students.u.edu.pk

** Assistant Professor Education Department Humanities, Education & Psychology. Air University, Islamabad sadaf.zamir@au.edu.pk

Introduction

The oversight of education in Pakistan is under the purview of the Ministry of Education. The Pakistani education system is typically categorized into three primary sectors: public and private schools. The majority of public schools primarily offer instruction in Urdu and serve the educational needs of individuals belonging to the middle and lower middle socioeconomic classes within the community. Furthermore, private schools can be categorized into two distinct sub-levels. Elite private schools, which mostly serve members of the upper class and upper middle class, make up the first sub-level.

Critical thinking abilities comprise multiple crucial elements, such as the ability to make decisions, solve problems, and use logic. Critical thinking necessitates decision-making, which entails weighing options, estimating outcomes, and making defensible decisions based on reasoning and supporting data (Perkins, 2017).

Science education usually include debate and teamwork, which gives students the chance to practice critical thinking skills. Through group work, students participate in scientific debate, share ideas, and present evidence-based arguments for their perspectives (Zohar & Nemet, 2016). Students must evaluate and critically analyze the advantages and disadvantages of their own and their classmates' arguments as part of collaborative activities (Sampson et al., 2018). By fostering reasoning abilities, weighing several points of view, and creating explanations that are supported by data, this strategy enhances critical thinking (Chinn et al., 2017).

Critical thinking abilities can be developed and enhanced in a science classroom setting. Through science education, students participate in scientific inquiry, hypothesis creation, experimental design, and data analysis. These tasks foster critical thinking, the evaluation of the facts, and the drawing of conclusions (Kuhn, 2015). In science learning environments, students are encouraged to challenge presumptions, ask questions, and develop logical explanations based on facts (Jimenez-Aleixandre et al., 2017). By engaging in practical activities, conducting scientific research, and working in groups to solve problems, students develop their critical thinking and decision-making skills (Bybee, 2015).

Statement of the Problem

Research and practice in education place a great deal of significance on the development of critical thinking abilities in primary school science instruction. But in order to truly comprehend and improve how science education affects critical thinking, the following issue must be taken care of:

Objectives of the Study

- To examine the distinctions between primary Science education in public and private systems with regard to critical thinking abilities.
- To pinpoint the differences between elementary science education in public and private systems with regard to decision-making abilities.
- To determine how decision-making abilities differ between elementary scientific education in public and private systems.

Hypothesis

Null Hypothesis (H_0): There is no discernible difference in critical thinking abilities between public and private systems at the primary school level.

Significance of the Study

This research may play a role in addition of existing knowledge. Other researcher may seek advantage for their research.
The study's conclusions can be used by policymakers to back evidence-based initiatives and policies that aim to foster critical thinking abilities in students from a variety of educational backgrounds.

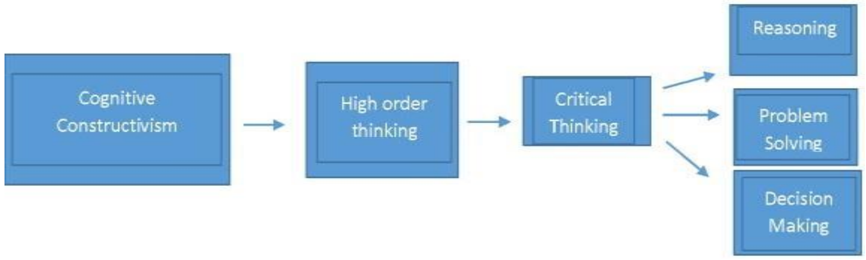
Rationale of the Study

The intention is to illustrate the diversity within educational streams by demonstrating differences in the fundamental degree of critical thinking skills between private and public institutions. Understanding these differences is essential to identifying possible differences in how kids from different educational backgrounds develop their critical thinking skills. The goal of the study is to better understand the effectiveness of various educational systems and promote educational justice by examining these disparities.

Theoretical Framework

In connection with this research, cognitive constructivism provides a theoretical foundation for understanding how children build critical thinking skills through science learning. Here's how cognitive constructivism fits into your research:

Fig. 1. Piaget's Theory of Cognitive Development by J Piaget.



Literature Review

Etymology of Critical Thinking

The etymology of the term "critical" may be traced back to the Greek word "Kritikos," which means "judgment," and the word "kriterion," which means "criteria or standards" (Kgosidialwa, 2021). The philosophical and intellectual foundations of critical thinking may be found in the philosophy of Socrates, who employed a probing questioning style to uncover the solutions to complicated issues from the human mind more than two thousand years ago. He believes that to reach a conclusion rationally, and serious inquiries must delve deeply into human thought.

History of Critical Thinking

Even though several researchers and academics have proposed various critical thinking models, they have had difficulty developing a unified critical thinking agreement. Paul et al. (2019) divided thedevelopment of critical thinking into three distinct periods. He separated these eras into the Greek, Middle, and Renaissance periods.

Critical Thinking-Related Activities or Strategies

In this sense, 'training' addressing integrating significant thinking-related activities or tactics into the Science teaching-and-learning process might be substantial. Many particular activities or tactics that link critical thinking with scientific education were mentioned in the article's findings. For instance, students can utilize diaries (Toman, 2014) to write down their questions and concerns for the instructor and other students to discuss afterwards. This method encourages the creation of questions, which engages children in science.

Critical Thinking and Science Learning

Additionally, the role of knowledge in the relationship between Critical Thinking and Science Learning can be interpreted in a variety of ways, including knowledge of the facts, content, and information associated with a particular academic subject or knowledge of the principles, criteria, and procedures related to the concept and development of Critical Thinking. The results of employing critical thinking in the classroom, teaching and learning activities for science learning,and using science themes for enhancing students' critical thinking may require further investigation and analysis. Science practice naturally entails critical thinking, making it potentially effective in science instruction. Its significance and function in science education and education generally cannot be disputed (Reynders et al., 2020).

Factors Influencing Students' Critical Thinking

Although many elements affect the development of critical thinking, the literature points to certain important ones, including the role of the instructor, communication, and topic expertise. According to Afify et al. (2019), there is a connection between thought and conduct. These behavioural influences impact thinking; for example, pupils who do not engage in criticalthinking exercises in the classroom learn less.

Critical Thinking Skills and Their Impacts on Students

According to Karakoc (2016) and Reichenbach (2001), individuals who possess the ability to engage in analytical thinking and evaluate the veracity or merit of an idea or belief prior to embracing it are commonly referred to as critical thinkers. According to Bustami et al. (2018) and Sarwanto et al.(2016), individuals who possess the capacity for critical thinking demonstrate proficiency in various areas. These include the skill to ask insightful questions, the ability to provide information that is both effective and efficient, the aptitude to make rational decisions based on trustworthy or improbable sources (objectivity), and the capability to reach consistent conclusions throughout the problem-solving process.

Methodology

The study followed a quantitative research method. Keeping in view the nature of data, which was acquired through test a quantitative research approach was preferred.

Research Design

A descriptive Research Design is used in the study. Descriptive research design aims to give a thorough and accurate description of the data got through critical thinking test.

Population

According to **PIERA (Private Educational Institutions Regularity Authority**) Islamabad, 717Private Schools are running in Islamabad, and 195 schools are in Urban Islamabad. According to**Federal Directorate of Education (FDE)** there are 975 public sector institutions working in Urban Islamabad. The enrollment in all public and private schools was near about forty eight thousands at elementary level.

Sample And Sampling Technique

The researcher used stratified random sampling in probability sampling as the population was large and heterogeneous. Detail is given in table 1.

Table 1.
Detail of Sample and Population

Sr No.	Sector	Total Elementary Schools	Sample Size	Students enrolled elementarylevel sampled school	Total no. of students enrolled at grade 6^{th} in sampled school
1	Public	975	3	515	99
2	Private	717	3	80	54

Instrument

A test was developed to check the student's critical thinking skills of students in grade 6^{th}. The test contained 15 questions. But the test was divided into 3 parts. Section one was about 5 MCQs about decision making, and each MCQs also had a space to explain why the students chose a specific answer. Same as that sections 2 and 3 were made. But the 5 questions in section 2 were about problem solving and in section 3 5 were about reasoning skills. Rubrics were also made for each section to score a test.

Data Collection

The researcher collected data. The researcher visited schools and conducted the test. The datawere collected by 54 students from private schools, 99 from public schools.

Data Analysis

Quantitative analysis requires first of all scoring of test according to the rubrics. One theresearcher was done with that, then the researcher has put all the data in excel sheet after that he copy all the entries with the results to the software SPSS. By putting the sum of scores and entries in the SPSS, the researcher got the percentage of every question. After the researcher only added the test scores without every mark of question, then he got the overall result of group means which group has got more marks and which group has gotten the lowest points. Then the researcher also adds only the strata values in SPSS and then add scores of decision making of all the groups in spss, through this, the researcher got to know about which group has higher level ofdecision making skills. After that the researcher separately checked about the section2 and section 3 results.

Validity and Reliability of the Data

Validity

The researcher herself made an instrument that consisted of 15 questions. Three experts with Ph.D degrees validated questionnaire.

TABLE 2.
Reliability Statistics

Scale	Cronbach's Alpha	N of Items
Decision making skills	.977	5
Problem-solving skills	.852	5
Reasoning Skills	.717	5

Table 2: The data collection instruments in the study are valid. Although the Reasoning Skills scale is the weakest of the three, it is enough nonetheless. The problem-solving and decision-making outcomes are high. Ability to Make Decisions(Cronbachs Alpha =.977) The internal consistency of this scale is fairly high. The value of alpha is very high (.977). Adequacy to address Problems (Cronbach Alpha =.852) The internal consistency of this scale is satisfactory. Ability to Reason (Cronbachs Alpha =.717) The internal consistency of this scale is moderate or acceptable. It is on the lower end on the permissible threshold.

Data Analysis and Interpretation

The analysis of data involves the process where the researcher starts to systemically organize, examine and integrate data in order to be able to search for patterns and relationships concerning the phenomenon being studied (Lawrence, 2011). It is through data analysis that the researcher can generate understanding, expand theory and advance knowledge (Lawrence, 2011).

Null Hypothesis (H_o): There is no significant difference in critical thinking skills at elementary level in Public and Private according to the null hypothesis (H_0).

Statements Wise Questionnaires of Participants

Table 3.

You are carrying out an experiment that requires the use of chemicals. What is the mostcrucial safety measure to take?

Responses	Frequency	Percent	Cumulative Percent
Wrong answer with no explanation	50	20.1	20.1
correct answer, with no explanation	149	59.8	79.9
Correct answer, with explanation	50	20.1	100
Total	249	100	

This table analyzes responses to a safety question about chemical experiments, revealing a concerning reliance on superficial knowledge rather than deep understanding.59.8% of respondents knew the correct safety measure but could not explain why it was crucial, indicating procedural knowledge without conceptual understanding. The results split evenly between wrong answers (20.1%) and fully explained correct answers (20.1%).While 79.9% answered correctly, only 20.1% could justify their answer, revealing a critical gap in safety understanding. The data suggests that most individuals (79.9%) may know basic lab safety rules by rote, but the majority lack the deeper comprehension needed to apply safety principles in novel situations.

Table 4.

On the Laboratory floor, You detect a chemical spill. What is the best course of action?

Responses	Frequency	Percent	Cumulative Percent
Wrong answer with no explanation	87	34.9	34.9
correct answer, with no explanation	148	59.4	94.4
Correct answer, with explanation	14	5.6	100
Total	249	100	

This table reveals a critical safety comprehension gap among laboratory personnel regarding chemical spill response.34.9% of respondents provided incorrect answers without explanation, indicating serious safety knowledge gaps.59.4% knew the correct action but couldn't explain why, suggesting memorized procedures without real comprehension. Only 5.6% demonstrated full understanding by providing both correct answers and explanations. The results are concerning for laboratory safety. While 65.1% answered correctly, the fact that 94.4% cannot justify their response indicates that most personnel would struggle to respond appropriately to real-world spill scenarios. This extreme lack of conceptual understanding (94.4%) poses significant safety risks and underscores the urgent need for improved safety training that emphasizes reasoning behind protocols.

Table 5.

You are assigned a group assignment in which you must design a model of the solar system. What is the most efficient way to execute the project?

Responses	Frequency	Percent	Cumulative Percent
Wrong answer with no explanation	69	27.7	27.7
correct answer, with no explanation	161	64.7	92.7
Correct answer, with explanation	19	7.6	100
Total	249	100	

This table reveals a significant gap between procedural knowledge and strategic understanding in project execution. Most respondents (64.7%) could identify the correct approach but couldn't explain why it was efficient, indicating surface-level understanding of project management. Only 7.6% demonstrated true comprehension by justifying their chosen method. Over one-quarter (27.7%) suggested incorrect approaches without explanation. While 72.3% recognized the efficient method, the extremely low explanation rate (7.6%) suggests most students lack deeper understanding of project management principles. This indicates that students may be repeating memorized steps rather than developing transferable problem-solving skills needed for complex tasks.

Table 6.

A student observes that her pet fish is not swimming as freely as usual. What should be theinitial step in resolving the issue?

Responses	Frequency	Percent	Cumulative Percent
Wrong answer with no explanation	112	48	45
correct answer, with no explanation	122	49	94
Correct answer, with explanation	15	6	100
Total	249	100	

This table reveals a critical deficiency in problem-solving methodology among students when faced with a practical issue.45% of respondents suggested incorrect initial steps without explanation, indicating fundamental flaws in their problem-solving approach.49% identified the correct first step but couldn't explain the reasoning behind it. Only 6% demonstrated true diagnostic thinking by providing both the correct step and their justification. The results show that 94% of students lack the ability to properly analyze and explain their approach to problem-solving. While 55% identified the correct initial action, the near-total absence of explanatory reasoning (6%) suggests students are operating on guesswork or memorization rather than developing systematic diagnostic skills. This indicates a need for improved training in analytical thinking and problem decomposition.

Table 7.

You are performing an experiment that requires you to heat a substance over a flame.What is the most critical safety measure to take?

Responses	Frequency	Percent	Cumulative Percent
Wrong answer with no explanation	68	27.3	27.3
correct answer, with no explanation	140	56.2	83.5
Correct answer, with explanation	41	16.5	100
Total	249	100	

This table reveals a moderate but concerning gap in safety understanding among respondents handling experimental heating procedures. A majority (56.2%) could identify the correct safety measure but couldn't explain why it was critical.16.5% demonstrated full comprehension by providing both the correct measure and its justification. Over one-quarter (27.3%) suggested incorrect safety measure. While 72.7% identified the proper safety protocol, the fact that 83.5% could not fully explain the reasoning indicates that most respondents lack deep understanding of flame safety principles. The presence of 16.5% with full understanding is higher than previous scenarios, suggesting some effective safety training, but significant improvement is still needed to ensure comprehensive safety comprehension.

Table 8.

A student is attempting to separate a sand and water mixture. Which is the followingapproach is most appropriate?

Responses	Frequency	Percent	Cumulative Percent
Wrong answer with no explanation	109	43.8	43.8
correct answer, with no explanation	20	48.2	92
Correct answer, with explanation	20	8	100
Total	249	100	

This table reveals a critical deficiency in understanding basic scientific separation methods among students.43.8% of students chose incorrect methods without explanation, indicating fundamental misunderstandings of physical separation principles.48.2% identified the correct method but couldn't explain the scientific reasoning behind their choice. Only 8% demonstrated true comprehension by justifying why their chosen method was appropriate. The results show alarming gaps in practical scientific knowledge. While 56.2% selected the correct approach, the extremely low explanation rate (8%) reveals that nearly all students lack conceptual understanding of mixture separation. This suggests that learning has been largely limited to memorization rather than developing genuine scientific reasoning skills applicable to practical problems.

Table 9.

A student tries to figure out the flavour of the liquid. Which of the following senses is themost useful?

Responses	Frequency	Percent	Cumulative Percent
Wrong answer with no explanation	114	45.8	45.8
correct answer, with no explanation	107	43	88.8
Correct answer, with explanation	28	11.2	100
Total	249	100	

This table reveals significant confusion among students about basic sensory identification and scientific safety practices.45.8% of students selected the wrong sense (likely suggesting dangerous options like taste) without explanation.43% identified the correct sense (smell) but couldn't explain why it's the safest and most appropriate method. Only 11.2% demonstrated full understanding by choosing smell and explaining its safety advantages over tasting. While 54.2% answered correctly, the high percentage of wrong answers (45.8%) suggests many students would consider unsafe methods. The low explanation rate (11.2%) indicates poor understanding of why certain senses are safer than others for unknown substances, highlighting a critical need for better safety education.

Table 10.

A student wants to investigate the impact of light on plant growth. Which of the followingis the best location for plant?

Responses	Frequency	Percent	Cumulative Percent
Wrong answer with no explanation	113	45.4	45.4
correct answer, with no explanation	120	48.2	93.6
Correct answer, with explanation	16	6.4	100
Total	249	100	100

This table reveals a critical lack of understanding about experimental design and controlled investigations among students.45.4% of students selected inappropriate locations without explanation, indicating fundamental misunderstandings of experimental controls.48.2% chose the correct location but couldn't explain why it was scientifically appropriate. Only 6.4% demonstrated true comprehension by justifying their choice with proper scientific reasoning. The results show that while 54.6% identified the correct location, the extremely low explanation rate (6.4%) reveals that nearly all students lack understanding of basic scientific method principles. This suggests students are guessing or memorizing answers rather than developing genuine experimental design skills.

Table 11.

A student is carrying out an experiment to determine the floating ability of various objects.Which of the following is most likely to float on water?

Responses	Frequency	Percent	Cumulative Percent
Wrong answer with no explanation	87	34.9	34.9
correct answer, with no explanation	131	52.6	87.6
Correct answer, with explanation	31	12.4	100
Total	249	100	

This table reveals moderate but insufficient understanding of basic density principles among students.34.9% selected incorrect objects without explanation, indicating misconceptions about buoyancy.Majority (52.6%) identified the correct object but couldn't explain the scientific principle (density).Only 12.4% demonstrated full understanding by correctly identifying the object and explaining why it floats.While 65.1% answered correctly, the low explanation rate (12.4%) shows that most students lack conceptual understanding of density. The results suggest that students can often predict floating behavior through observation or guessing, but few grasp the underlying scientific principle, indicating a need for more effective physics education focused on conceptual understanding rather than just factual recall.

Table 12.

A student is doing an experiment to compare plant growth in various types of soil. Toprovide a fair test, which of the following should be kept constant?

Responses	Frequency	Percent	Cumulative Percent
Wrong answer with no explanation	180	72.3	72.3
correct answer, with no explanation	60	24.1	96.4
Correct answer, with explanation	9	3.6	100
Total	249	100	

This table reveals a critical deficiency in understanding fundamental scientific principles of experimental design.72.3% of students failed to identify the correct constants for a fair test, indicating widespread misunderstanding of controlled experiments.Only 24.1% identified correct constants but couldn't explain the reasoning behind controlled variables.A mere 3.6% demonstrated full comprehension by explaining why specific factors must be constant for a valid experiment.The results reveal an alarming gap in scientific literacy. The extremely high error rate (72.3%) combined with the near-absence of explanatory understanding (3.6%) suggests that students lack basic comprehension of how to design valid experiments. This indicates a fundamental failure in science education to teach critical thinking and experimental methodology, requiring urgent educational intervention.

Table 13.

A student noticed that a glass filled with water left outside on a chilly night froze. Whatmay be drawn from the conclusion?

Responses	Frequency	Percent	Cumulative Percent
Wrong answer with no explanation	123	49.4	49.4
correct answer, with no explanation	119	47.8	97.2
Correct answer, with explanation	7	2.8	100
Total	249	100	

This table reveals a critical deficiency in students' ability to draw logical conclusions from basic scientific observations.49.4% of students drew incorrect conclusions from the observation, indicating fundamental flaws in logical reasoning.47.8% reached the correct conclusion but couldn't explain the scientific reasoning behind it.Only 2.8% demonstrated true scientific reasoning by providing both the correct conclusion and its explanation.The results show that while 50.6% reached the right conclusion, the near-total absence of explanatory reasoning (2.8%) reveals that students are guessing or using memorized answers rather than developing genuine analytical skills. This extreme lack of scientific reasoning ability (97.2% unable to explain) indicates a critical need for educational focus on developing inference and conclusion-drawing skills.

Table 14.

A student wants to investigate the impact of various soil types on plant development. Which of the following experimental setups would be the best?

Responses	Frequency	Percent	Cumulative Percent
Wrong answer with no explanation	185	74.3	74.3
correct answer, with no explanation	62	24.9	99.2
Correct answer, with explanation	2	0.8	100
Total	249	100	

This table reveals an alarming deficiency in students' understanding of experimental design and scientific methodology.4.3% of students selected incorrect experimental setups, indicating widespread misunderstanding of controlled experiments. Only 24.9% identified the correct setup but couldn't explain the scientific reasoning behind their choice. A mere 0.8% demonstrated true comprehension by justifying their experimental design choice. The results reveal a crisis in scientific education. The overwhelming majority (99.2%) of students lack the ability to design or explain proper experimental methodology. This near-total absence of experimental design skills suggests that current science education is failing to teach fundamental investigative thinking, requiring immediate and substantial educational reform.

Table 15.
When a glass of water is left outside on a hot day, water droplets accumulate on outside ofthe glass, according to a student. What is the most likely explanation for this occurrence?

Responses	Frequency	Percent	Cumulative Percent
Wrong answer with no explanation	141	56.6	56.6
correct answer, with no explanation	104	41.8	98.4
Correct answer, with explanation	4	1.6	100
Total	249	100	

This table reveals a critical failure in students' understanding of basic physical science concepts. 56.6% of students provided incorrect explanations for condensation, indicating fundamental misunderstandings of states of matter.41.8% identified the correct phenomenon but couldn't explain the scientific process. Only 1.6% demonstrated genuine comprehension by explaining the condensation process. The results show an alarming deficiency in scientific literacy. While 43.4% correctly identified condensation, the near-absent explanatory ability (1.6%) reveals that students lack basic understanding of everyday physical phenomena. This suggests that science education is failing to help students connect classroom learning to real-world observations, requiring fundamental changes in science teaching methodology.

Table 16.
Which of the following is the best conductor of electricity?

Responses	Frequency	Percent	Cumulative Percent
Wrong answer with no explanation	141	56.6	56.6
correct answer, with no explanation	83	33.3	90
Correct answer, with explanation	25	10	100
Total	249		

This table reveals significant gaps in students' understanding of electrical conductivity concepts. 56.6% of students selected incorrect conductors, indicating widespread misconceptions about electrical properties of materials.33.3% identified the correct conductor but couldn't explain the scientific reasoning. Only 10% demonstrated full understanding by correctly identifying and explaining why their choice is the best conductor. The results show that while 43.4% answered correctly, the low explanation rate (10%) indicates most students lack conceptual understanding of electrical conductivity principles. The high error rate (56.6%) suggests significant confusion about material properties, highlighting a need for improved hands-on science education to build foundational physics knowledge.

Discussion

Elementary school pupils learn science in a variety of public and private schooling environments. The study investigated the relationship between science process skills and critical thinking abilities as well as the variations in science learning and critical thinking abilities among students in the two educational systems using demographic data, descriptive statistics, correlation, and regression analysis.

Important information about the mean scores, standard deviations, and confidence intervals of the critical thinking abilities of the students in the three systems was obtained from the descriptive statistics of those skills. The distribution of scores within each group and the average level of critical thinking skills were determined with the use of these statistics. The effectiveness of the regression models in predicting critical thinking abilities based on science learning characteristics was also demonstrated by the Standard Error of the Estimate.

Overall, this comparison study's results showed that science instruction is essential for improving elementary school kids' critical thinking abilities in a variety of learning environments. Stronger critical thinking skills are expected to develop in pupils exposed to excellent science education, according to the positive correlations and significant regression models. But the report also highlighted

Conclusion

The study offered insightful information about elementary school pupils in public and private schools' use of critical thinking abilities when learning science. The substantial regression models and favorable correlations highlighted the value of science education in helping students enhance their critical thinking skills. The study's conclusions and evidence-based suggestions can be used as a basis by educational stakeholders to create science curricula and instructional tactics that effectively develop students' critical thinking abilities and equip them for problems in the classroom and in real life.

Recommendations

The study's findings support a number of empirically supported suggestions for improving scientific education's integration with critical thinking development in primary school:

1. Curriculum planners and education policy makers should place a strong emphasis on including inquiry-based, hands-on science learning activities that foster critical thinking abilities.
2. Encouraging cross-disciplinary integration of science concepts with other

subjects can give students opportunities to apply their critical thinking skills in real-life scenarios.

3. Professional development programs can provide educators with the necessary tools and techniques to facilitate science learning experiences that stimulate critical thinking among their students. Combining

References

Afify, M. K. (2019). The influence of group size in the asynchronous online discussions on the development of critical thinking skills, and on improving students' performance in online discussion forum. *International Journal of Emerging Technologies in Learning (Online), 14(*5), 132.

Bustami, Y., Leliavia, L., Elisabeth, N., Gandasari, A., & Ratnasari, D. (2020). Contextual teaching learnıng in human digestive system: The contribution of critical thinking skills. *Biosfer: Jurnal Pendidikan Biologi*, *13*(1), 101-113.

Bybee, R. W. (2015). *The BSCS 5E instructional model and 21st century skills*. Colorado Springs, CO: BSCS Science Learning.

Sarwanto, Fajari, L. E. W., & Chumdari. (2021). Critical thinking skills and their impacts on elementary school students. *Malaysian Journal of Learning and Instruction*, *18*(2), 161–187. https://doi. org/ 10.32890/ mjli2021.18.2.6

Chinn, C. A., Buckland, L. A., & Samarapungavan, A. (2017). Expanding the dimensions of epistemic cognition: Arguments from philosophy and psychology. *Educational Psychologist, 52(*2), 103-125.

Christenson, N., Rundgren, S.N.C.,& Zeidler, D.L. 2014. The Relationship of Discipline Back- ground to Upper Secondary Students' Argu- mentationon Socioscientific Issues. Research in Science Education, 44: 581–601

Jimenez-Aleixandre, M. P., Bugallo-Rodriguez, A., & Duschl, R. A. (2017). Argumentation in science education: An overview. In M. P. Jimenez-Aleixandre, A. Bugallo-Rodriguez, & R. A. Duschl (Eds.), *Argumentation in science education: Perspectives from classroom-based research* (pp. 3-21). Springer.

Karakoc, M. (2016). The significance of critical thinking ability in terms of education. *International Journal of Humanities and Social Science*, *6*(7), 81-84.

Kgosidialwa, M. G. (2021). *Critical thinking skills in tertiary education in Botswana* (Doctoral dissertation, Stellenbosch: Stellenbosch University).

Kuhn, D. (2015). Thinking together and alone. *Educational Researcher, 44(*1), 46-53.

Lawrence, W. (2014). *Social Research Methods-Qualitative and Quantitative Approaches*. British Library Cataloguing-in-Publication Data.

Paul, R., & Elder, L. (2019). Critical thinking: The nature of critical and creative thought. *Journal of Developmental Education, 30(*2), 34-35.

Perkins, D. N. (2017). *Teaching critical thinking: Lessons from cognitive science*. Cambridge University Press.

Radia, B. (2019). Approaching a reading course via moodle-based blended learning: EFL learners' insights. *Modern Journal of Language Teaching Methods (MJLTM), 9(*11), 1-12.

Reichenbach, B. R. (2001). *Introduction to critical thinking.* McGraw Hill Higher Education: Boston.

Reynders, G., Lantz, J., Ruder, S. M., Stanford, C. L., & Cole, R. S. (2020). Rubrics to assess critical thinking and information processing in undergraduate STEM courses. *International Journal of STEM Education, 7,* 1-15.

Sampson, V., Enderle, P., Grooms, J., & Witte, S. (2018). Promoting and assessing scientific reasoning through argumentative writing in the laboratory. *Journal of Research in Science Teaching, 55(*1), 122-142.

Toman, V. C., Chan, K. W., & Chan, T. (2017). Thinking skills and critical thinking disposition: Their relationships among senior high school students in Taiwan. *Journal of Research in Education Sciences, 62(*3), 207-242.

Zohar, A., & Nemet, F. (2016). Fostering students' knowledge and argumentation skills through dilemmas in human genetis. *International Journal of Science Education, 38(*6), 1045-1066.c

Citation of this Article:
Khan, Z., & Ahmed, S.Z., (2024). Critical Thinking Skills in Science Learning at Elementary Level: A Comparative Study of Public, Private Schools. *Journal of Science Education,6(1)*, 53–70