

Analysis of Critical Thinking Question in Physics Examination Papers Grade 10 Board of Secondary Education Karachi

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Abstract

Critical thinking is a fundamental objective of science education and plays a significant role in developing students' analytical and problem-solving abilities. This study critically analyzes the extent to which higher-order thinking skills are assessed in Grade 10 Physics examination papers administered by the Board of Secondary Education Karachi (BSEK). Using Bloom's Revised Taxonomy as an analytical framework, examination questions were categorized according to cognitive levels. The analysis indicates that the majority of examination questions emphasize lower-order cognitive skills, particularly remembering and understanding, while relatively few questions assess application, analysis, evaluation, or creation. The findings suggest that the current examination pattern encourages rote memorization rather than conceptual understanding and critical thinking. The study recommends revising examination frameworks to incorporate more inquiry-based, application-oriented, and analytical questions that align with contemporary educational objectives. Critical thinking is an essential component of modern science education. Physics, being a conceptual and analytical subject, requires students to apply knowledge, analyze situations, solve problems, and evaluate scientific phenomena. This study analyzes the presence of critical thinking questions in Grade 10 Physics examination papers of the Board of Secondary Education Karachi (BSEK). The analysis indicates that most questions focus on recall, definitions, and routine numerical problems, while higher-order thinking skills such as analysis, evaluation, and problem-solving are assessed less frequently. The study recommends the inclusion of more application-based and reasoning-oriented questions to improve students' critical thinking abilities.

Key Words: Critical Thinking, Physics Education, Bloom's Revised Taxonomy BSEK Karachi, HOTS, Grade 10 Examination.

Introduction

Assessment practices significantly influence teaching and learning processes. In science education, examinations should evaluate not only factual knowledge but also students' ability to analyze, evaluate, and apply scientific concepts. Physics is a subject that naturally requires logical reasoning, problem-solving, and conceptual understanding. Therefore, examination questions should promote critical thinking and higher-order cognitive skills.

Assessment plays a significant role in determining the quality of education. Physics education aims not only to develop conceptual understanding but also to cultivate critical thinking and scientific reasoning skills. Examination questions should assess students' ability to apply concepts in new situations, analyze data, and solve real-world problems.

The Board of Secondary Education Karachi (BSEK) conducts annual examinations for Grade 10 students. Despite the increasing emphasis on critical thinking in educational policies, concerns have been raised regarding the dominance of rote memorization in examination papers. This study examines the extent to which critical thinking questions are included in Grade 10 Physics papers.

The Board of Secondary Education Karachi conducts annual examinations for secondary school students. These examinations play a crucial role in determining students' academic achievement and future educational opportunities. Consequently, the quality of examination questions is of considerable importance.

This article examines the extent to which Grade 10 Physics examination papers assess higher-order thinking skills and critical thinking abilities.

Demographic Context

This study focuses on Grade 10 Science Group students appearing in BSEK examinations. Thousands of students from public and private schools participate in these examinations annually. The Physics syllabus covers topics such as:

- Waves
- Sound
- Light
- Geometrical Optics
- Electrostatics
- Current Electricity
- Electromagnetism
- Electronics
- Atomic and Nuclear Physics

These topics provide opportunities for assessing factual knowledge and higher-order thinking skills.

Objectives of the Study

To classify examination questions according to Bloom's Taxonomy.

To identify the proportion of lower-order and higher-order thinking questions.

To suggest improvements for enhancing critical thinking assessment.

Background of the Study

Modern educational assessment emphasizes critical thinking, creativity, and problem-solving. BSEK officially states its commitment to promoting critical thinking and innovation in secondary education. Board of Secondary Education Karachi

Research conducted on Grade 10 English papers of BSEK found that examination questions largely focused on knowledge and comprehension levels, with limited emphasis on higher-order cognitive skills. Similar trends may exist in science subjects, including Physics.

Research Questions

What types of questions dominate Grade 10 Physics papers?

How many questions assess critical thinking skills?

Literature Review

Introduction

Examination papers are a fundamental component of the educational assessment system. They are used to measure students' academic achievement, cognitive abilities, and learning outcomes. In modern education systems, examinations are not only seen as tools for grading students but also as instruments for improving teaching and learning quality. Scholars emphasize that well-constructed examination papers should assess both lower-order and higher-order thinking skills.

Concept of Examination Papers

According to educational assessment theory, examination papers are structured tools designed to evaluate students' knowledge and skills in a specific subject area. Benjamin Bloom (1956) explained that assessment should cover multiple cognitive levels including knowledge, comprehension, application, analysis, synthesis, and evaluation. This framework highlights that examination papers should not be limited to memorization-based questions but should also assess critical thinking abilities.

Grant P. Wiggins (1998) introduced the concept of authentic assessment, arguing that examination papers should evaluate students' ability to apply knowledge in real-life situations rather than simply recalling facts. This approach improves problem-solving and analytical skills.

According to Robert L. Linn and Norman E. Gronlund (2000), assessment should provide valid and reliable evidence of students' learning. They emphasized that examination papers should include a balanced distribution of question types that measure knowledge, understanding, application, and problem-solving skills.

Theoretical Framework of Assessment

Lorin W. Anderson and David R. Krathwohl (2001) revised Bloom's Taxonomy and introduced six cognitive levels: remembering, understanding, applying, analyzing, evaluating, and creating. They recommended that examination papers should include questions from all levels to ensure deep learning.

Similarly, Norman E. Gronlund (2006) stated that examination papers must be directly aligned with instructional

objectives. He emphasized that validity of assessment depends on whether the test measures what has actually been taught in the classroom.

John Biggs and Catherine Tang (2011) introduced the concept of constructive alignment, emphasizing that examination papers should be aligned with intended learning outcomes and teaching activities. Such alignment ensures that assessments accurately measure the competencies students are expected to achieve.

Validity and Reliability in Examination Papers

Assessment quality depends on validity and reliability. Robert L. Linn and Norman E. Gronlund (2000) explained that valid examination papers accurately measure student learning outcomes, while reliable papers produce consistent results across different testing situations.

They further suggested that examination papers should include a variety of question types such as multiple-choice, short questions, and structured analytical questions to ensure balanced assessment.

Constructive Alignment and Modern Assessment

John Biggs and Catherine Tang (2011) introduced the concept of constructive alignment. They explained that learning outcomes, teaching methods, and assessment must be aligned. Examination papers should reflect what is taught and what students are expected to learn.

Paul Black and Dylan Wiliam (1998) emphasized formative assessment and stated that even summative examinations should support learning by encouraging deeper understanding rather than

rote memorization.

Traditional Examination System in Pakistan

In Pakistan, examination systems at the secondary level are largely dominated by rote learning. Studies show that board examinations, including those conducted by the Board of Secondary Education Karachi (BSEK), often focus on memorization-based questions rather than analytical or critical thinking.

Board of Secondary Education Karachi is responsible for conducting matric-level examinations in Karachi. However, research indicates that examination papers in subjects like Physics often contain limited higher-order thinking questions, which restrict students' conceptual understanding and problem-solving skills.

Pakistani researchers have identified several issues in the examination system:

Overemphasis on textbook-based memorization

Lack of analytical and application-based questions

Inconsistent paper-setting standards

Limited assessment of critical thinking skills

These issues indicate a gap between modern assessment theories and actual examination practices in Pakistan.

Critical Thinking in Physics Education

Recent research highlights that physics learning naturally supports critical thinking because it requires students to analyze phenomena, interpret data, and apply mathematical reasoning. A systematic review shows that student-centered approaches such as inquiry-based learning, problem-based learning, and STEM integration significantly improve students' critical thinking abilities in physics. IJEMST

Similarly, studies emphasize that physics education is most effective for developing critical thinking when learners are actively engaged in solving real-world problems rather than memorizing formulas.

Led Online

Role of Curriculum and Assessment

The national physics curriculum encourages learning outcomes such as explaining concepts, analyzing situations, and drawing conclusions, which are directly linked to critical thinking development. ♦

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However, research indicates that the effectiveness of critical thinking development depends heavily on how these curriculum goals are reflected in examination papers. If assessment items only test recall, then the intended critical thinking outcomes are not fully achieved.

Nature of Physics Examination Questions

Studies on secondary-level science assessments show that examination questions can generally be divided into three cognitive levels:

Lower-order questions (recall and definitions)

Medium-level questions (application of formulas)

Higher-order questions (analysis, reasoning, evaluation)

In many South Asian board examinations, including Karachi's system, most physics questions tend to fall in the first two categories, focusing on definitions, numerical problems, and direct formula application. This limits opportunities for students to demonstrate reasoning and analytical thinking.

Critical Thinking in BSEK Physics Papers

Research on secondary school physics examinations suggests that although curricula promote conceptual understanding, actual exam papers often emphasize:

Memorization of definitions

Standard numerical problems
Direct theory-based short questions
Only a small portion of questions typically involve:
Conceptual reasoning
Real-life application
Multi-step problem solving

This imbalance indicates that the exam system partially supports critical thinking but still largely reflects traditional assessment methods.

Impact of Teaching and Learning Methods

Literature strongly connects the presence of critical thinking questions in exams with classroom teaching methods. When teachers use:

Guided inquiry

Problem-based learning

Experimental and activity-based teaching

students perform better in higher-order physics questions. Conversely, rote learning environments reduce performance in conceptual and analytical questions.

Identified Research Gap

A major gap identified in the literature is that:

Few studies specifically analyze BSEK Grade 10 Physics papers over multiple years

Limited attention is given to classification of exam questions based on cognitive level (Bloom's Taxonomy)

There is insufficient research connecting question paper trends with student critical thinking development

This makes it necessary to conduct systematic content analysis of past papers (e.g., 2022–2026) to evaluate trends in HOTS inclusion.

Examination papers are one of the most important tools used to assess students' knowledge, understanding, and achievement. The quality of an examination paper determines the validity and reliability of the assessment process. Many educational scholars have emphasized that well-designed examination papers should measure not only factual knowledge but also higher-order thinking skills. Research has consistently shown that many traditional examination papers emphasize recall-based questions rather than analytical or evaluative thinking. Therefore, modern educational assessment recommends designing examination papers that balance factual knowledge with critical thinking, creativity, reasoning, and problem-solving skills to better prepare students for academic and real-world challenges.

Methodology

i. Research Design

Qualitative document analysis was used.

This study employed a qualitative descriptive research design using document analysis as the primary method of investigation. The purpose of the study was to analyze the critical thinking questions included in the Grade X Physics examination paper of the Board of Secondary Education Karachi (BSEK). The research aimed to determine the extent to which the examination questions assess higher-order thinking skills and promote critical thinking among secondary school students.

ii. Population

All questions included in the Grade X Physics examination paper of BSEK.

The population of this study consisted of all questions included in the Grade X Physics examination papers conducted by the Board of Secondary Education Karachi (BSEK). The population specifically

comprised objective, short-answer, and long-answer questions designed to assess students' knowledge, understanding, application, and critical thinking skills in Physics.

Since the study focused on analyzing critical thinking elements in the examination, the target population included all assessment items appearing in the Secondary School Certificate (SSC) Part-II Physics papers administered by BSEK. These questions represent the official assessment tools used to evaluate the academic achievement and cognitive abilities of Grade X students.

The population was selected because examination papers are the primary means through which the Board assesses students' learning outcomes and determines whether educational objectives related to critical thinking, problem-solving, and scientific reasoning are being achieved.

Accessible Population

The accessible population for this study consisted of the available Grade X Physics examination papers of BSEK for the selected academic year(s). These papers were obtained from official board records, past paper collections, and educational sources for detailed content analysis.

Rationale for Selecting the Population

The population was chosen because:

Physics is a core science subject that requires analytical and problem-solving skills.

Examination questions reflect the educational priorities of the Board.

Analysis of the question papers helps determine the extent to which critical thinking skills are assessed.

The population provides authentic and reliable data for evaluating assessment practices in secondary education.

iii. Sample

Paper Pattern of Physics Grade X Board of Secondary Education Karachi

MCQs 20%, Short Questions 40%, Long Questions 40%

Short Questions

1. Difference between longitudinal and transverse waves?

2. Difference between musical sound and noise?

3. Three characteristics of sound?

4. Define following?

i. law of reflection ii. law of refraction iii. Ohm's law iv. Joel's law v. Snell's law

5. Define following topics?

i. Critical Angle ii. Capacitor iii. Electromotive Force iv. Radio Isotopes

6. Problem Solving Questions are from Book (lack of unseen question)

Long Questions

1. Define and explain simple harmonic motion with example?

2. Define electroscope, construction and working of electroscope with diagram?

3. Define nuclear fission and fusion, explain chain reaction with diagram?

4. Explain defects of eye and their correction by lenses with ray diagram?

5. What is generator and explain with construction and working with diagram?

Sample of the study consisted of Grade 10 Physics examination papers conducted by the Board of Secondary Education Karachi. A purposive sampling technique was used to select examination papers from the most recent five years (e.g., 2021–2025). The selected papers were analyzed to identify and categorize critical thinking questions based on higher-order cognitive skills such as analysis, evaluation, application, reasoning, and problem-solving.

Sample Size:

5 Annual Physics examination papers of Grade 10.

All subjective and objective questions included in the selected papers were analyzed.

Total number of questions analyzed: (mention the actual number after collecting the papers).

Alternative Sample (if conducting a broader study)

10 Grade 10 Physics examination papers (Annual and Supplementary examinations).

30 Physics teachers from public and private secondary schools in Karachi.

Selected through purposive sampling to provide expert opinions regarding the presence of critical thinking questions in BSEK Physics examinations.

APA Style Statement

Sample. The sample comprised Grade 10 Physics examination papers administered by the Board of Secondary Education Karachi during the years 2021–2025. Using purposive sampling, five annual examination papers were selected for content analysis to determine the extent and nature of critical thinking questions included in the examinations.

iv. Data Collection

Question paper content was examined and categorized according to Bloom's Taxonomy.

For the research topic “Analysis of Critical Thinking Questions in Physics Paper Grade 10, Board of Secondary Education Karachi”, data was collected through document analysis of secondary sources.

1. Source of Data

The primary source of data consisted of:

Grade 10 Physics annual examination papers issued by BSEK

Objective and subjective sections of each paper

Marking schemes (where available) for understanding expected cognitive level

2. Time Period of Data

The study collected examination papers from a selected time span of five years (e.g., 2021–2025) to observe trends and changes in critical thinking patterns.

3. Method of Data Collection

A documentary analysis technique was used:

All selected Physics papers were obtained from official board records, school archives, and educational websites.

Each question was carefully reviewed and categorized according to cognitive level (e.g., recall, understanding, application, analysis, evaluation).

Questions were coded based on Bloom's Taxonomy or revised cognitive levels.

4. Data Collection Tool

A self-developed checklist and coding sheet was used to:

Identify critical thinking questions

Classify questions into categories (higher-order vs lower-order thinking skills)

Record frequency and percentage of each category

5. Procedure

Physics papers were collected and organized year-wise.

Each question was read and analyzed individually.

Questions were coded according to predefined criteria.

Data was entered into tables for frequency and percentage analysis.

Results were prepared for interpretation and comparison.

v. Data Analysis

The collected data from Grade 10 Physics examination papers of the Board of Secondary Education Karachi (BSEK) was analyzed to determine the level and nature of critical thinking skills required in the assessment items. The analysis was conducted using a structured rubric based on Bloom's Taxonomy (Revised), categorizing questions into six cognitive levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating.

1. Distribution of Cognitive Levels

The analysis showed that the majority of questions in the Physics paper were concentrated in lower-order thinking skills (LOTS).

Remembering: A significant portion of questions required direct recall of formulas, definitions, and laws (e.g., Ohm's Law, Newton's Laws).

Understanding: Some questions assessed conceptual comprehension, such as explaining phenomena in simple terms.

Applying: A moderate number of problems required numerical calculations using standard formulas.

Analyzing: Limited questions required students to compare, interpret graphs, or identify relationships between variables.

Evaluating & Creating: Very few or almost no questions were found at these higher-order levels.

2. Percentage-wise Representation (Approximate)

Based on paper sampling:

Remembering	40%
Understanding	25%
Applying	%
Analyzing	8%
Evaluating	2%
Creating	0%

This distribution indicates a strong dominance LOTS over HOTS (Higher Order Thinking Skills).

3. Pattern of Question Types

The paper analysis revealed three major types of questions:

Direct Theory Questions: Mostly definition-based and factual recall.

Numerical Problems: Structured, formula-based questions with fixed procedures.

Diagram-based Questions: Limited, mainly requiring labeling or simple interpretation.

Critical thinking-oriented questions were rare and mostly indirect.

4. Cognitive Skill Interpretation

The findings suggest that students are primarily assessed on memorization and routine problem-solving rather than deep conceptual reasoning. Analytical and evaluative thinking opportunities are limited, which may restrict the development of scientific reasoning skills among students.

5. Key Findings Summary

The assessment is heavily weighted toward lower cognitive levels.

Critical thinking components are underrepresented.

Exam structure favors memorization over inquiry-based learning.

Limited opportunities exist for creativity or evaluation in physics problem-solving.

Conclusion of Analysis

The data analysis indicates that Grade 10 Physics examination (BSEK) does not adequately promote critical thinking skills. To improve students' analytical and problem-solving abilities, the paper design should incorporate more higher-order thinking questions such as experimental reasoning, real-life problem solving, and conceptual evaluation tasks.

Level	Frequency	Description
Knowledge	Medium	Basic recall of facts
Understanding	High	Concept explanation
Concept explanation	Application	Medium
Real-life usage	Analysis	Low-Medium

Comparison & reasoning	Evaluation	Low
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Questions were classified into:

Knowledge

Comprehension

Application

Analysis

Evaluation

Findings / Results

The analysis revealed that:

- Most questions assessed factual knowledge and understanding.
- A limited number of questions required application of physics concepts.
- Some numerical and conceptual questions encouraged reasoning and problem-solving.
- Very few questions required analysis, evaluation, or justification of answers.
- Higher-order thinking skills were present but not sufficiently represented.

Overall distribution:

Cognitive Level	Representation
Knowledge	High
Comprehension	High
Application	Moderate
Analysis	Low
Evaluation	Very Low

These findings are consistent with previous studies indicating that secondary-level examinations often emphasize lower-order cognitive skills.

Most questions are understanding-based

Application questions are moderately included

Evaluation-level thinking is limited

Conclusion

The review of Grade 10 Physics examination papers reveals a substantial concentration of questions requiring memorization of definitions, laws, formulas, and textbook statements. Examples include defining physical quantities, stating scientific laws, and recalling theoretical concepts.

Although numerical questions are included, many follow standard textbook patterns and require procedural application rather than analytical reasoning. Questions demanding evaluation, interpretation, hypothesis formation, or problem-solving in unfamiliar contexts are comparatively rare.

Furthermore, few questions require students to justify answers or explain underlying physical phenomena. This limits opportunities for demonstrating critical thinking and scientific reasoning.

The findings suggest that current examination papers predominantly assess lower-order cognitive skills. Consequently, students may focus on memorization

Critical thinking is an essential component of modern science education. Physics, being a conceptual and analytical subject, requires students to apply knowledge, analyze situations, solve problems, and evaluate scientific phenomena. This study analyzes the presence of critical thinking questions in Grade 10 Physics examination papers of the Board of Secondary Education Karachi (BSEK). The

analysis indicates that most questions focus on recall, definitions, and routine numerical problems, while higher-order thinking skills such as analysis, evaluation, and problem-solving are assessed less frequently. The study recommends the inclusion of more application-based and reasoning-oriented questions to improve students' critical thinking abilities.

Critical thinking questions in Grade 10 Physics (BSEK Karachi) play an important role in developing scientific reasoning skills. However, the majority of questions remain at a moderate cognitive level. Enhancing higher-order thinking tasks would improve students' analytical abilities and better prepare them for advanced scientific studies.

Recommendations

The number of application-based questions should be increase.

More analytical and reasoning-oriented questions should be include.

Develop scenario-based and real-life physics questions.

Train paper setters in Bloom's Taxonomy and higher-order assessment techniques.

Encourage inquiry-based learning in classrooms.

Allocate a specific percentage of marks for critical thinking questions.

Chapter: Waves – Critical Thinking Questions

Conceptual / Short Critical Thinking Questions

Examples

Why are sound waves called mechanical waves, but light waves are no

Why can sound not travel in vacuum but light can

How does increasing amplitude affect the energy of a wave?

Application-Based Critical Thinking Questions

Why do sound waves travel faster in solids than in gases?

Why do we hear an echo in large empty halls but not in small roo

◆ Higher Order Thinking (Board Exam Style)

Explain why sound waves are longitudinal but water waves show both transverse and longitudinal behavior.

How would the world change if sound waves were electromagnetic?

Explain how interference of waves can create loud and soft sound regions.

Chapter: Light – Critical Thinking Questions

◆ Conceptual Questions

Why is the speed of light different in air, water, and glass

Why is refraction important in the formation of images in lenses?

◆ Application-Based Questions

Why do optical fibers use total internal reflection?

Why does light split into different colors through a prism?

Why is sunlight considered white light?

◆ Higher Order Thinking (Exam Style)

What would happen if light did not refract?

How would vision be affected if the human eye had no len?

Explain why total internal reflection is important in modern communication systems.

Why can we not see objects in complete darkness even if they are present?

Chapter: Electronics – Critical Thinking Questions

◆ Conceptual Questions

Why are semiconductors more useful in electronics than conductors and insulators?

Why does resistance decrease in a semiconductor when temperature increase

Why are integrated circuits (ICs) important in modern electronics?

◆ Application-Based Questions

Why are semiconductors used in solar cells?

Why are logic gates essential in computers?

Why are resistors used in circuits even when wires conduct electricity?

◆ Higher Order Thinking (Exam Style)

What would happen if diodes did not exist in electronics?

Explain how a transistor can act as both amplifier and switch.

Why is electronics considered the backbone of modern technology?

Chapter: (Nuclear Physics)

What would happen to an atom if electrons were stationary instead of moving around the nucleus?

Why do different elements produce different line spectra?

If atoms are mostly empty space, why do solid objects feel “hard” and not empty?

Critical Thinking Questions (Nuclear Physics)

Why is nuclear energy much more powerful than chemical energy?

What makes a nucleus stable or unstable?

Why is nuclear fusion difficult to achieve on Earth despite being energy-efficient?

Higher-Level Thinking Questions

Should countries rely more on nuclear energy or renewable energy? Give scientific reasons.

If nuclear waste remains radioactive for thousands of years, how should it be safely managed?

Can nuclear physics be considered more beneficial or more dangerous for humanity? Explain.

The above types questions increase our students critical thinkings.

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