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Teaching Critical Thinking in Science: Perceptions and Practices of Secondary School Science Teachers in Panjgur, Balochistan

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ABSTRACT

Critical thinking is an essential skill in science education, enabling students to analyze, evaluate, and synthesize information for problem-solving and informed decision-making. The aims of the study to explore that to what extent science teachers are familiar with the concept of critical thinking and practicing its development strategies in their classrooms secondary schools in Panjgur, Balochistan, as this study is confined to the 24 male secondary schools in Panjgur. Using a qualitative research design, data was collected through semi- structured interviews with 15 secondary school science teachers to gain insights into their perceptions, instructional strategies, and the challenges they face in fostering critical thinking among students. Data were analyzed through a thematic approach. The findings reveal that while teachers recognize the importance of critical thinking, their perceptions often focus on problem-solving rather than broader cognitive and dispositional aspects such as open- mindedness and analytical reasoning. Various pedagogical practices were identified, including classroom discussions, Socratic questioning, inquiry-based learning, cooperative learning, and project-based assignments. However, several barriers hinder the effective implementation of these strategies, including a rigid curriculum, examination-driven education, lack of teacher training, inadequate resources, and large class sizes. This study highlights the need for professional development programs to enhance teachers' ability to integrate critical thinking into their teaching. It also emphasizes the importance of curriculum and assessment reforms that encourage higher-order thinking skills. Addressing these challenges through improved training, resource allocation, and pedagogical innovation will be crucial in equipping students with the critical thinking skills necessary for academic success and real-world problem-solving.

Keywords: *Teaching, Critical Thinking, Science Education, Secondary Schools*

INTRODUCTION

Critical thinking is an essential component of science education, equipping students with the ability to analyze, evaluate, and synthesize information systematically. The significance of critical thinking in the modern, dynamic, and complex world has been highlighted by several education scholars (Lu & Xie, 2024; Lu, 2024). To effectively prepare students for the challenges of the 21st century, teachers need to intentionally integrate the teaching of critical thinking skills into their instructional practices (Meza et al., 2024). This requirement emerges from the evolving educational context, where technological innovations and global challenges call for individuals with strong analytical and problem-solving competencies (Chen et al., 2024). It fosters independent reasoning, problem-solving, and decision-making skills, which are crucial for navigating an increasingly complex world. Science education plays a pivotal role in shaping students' analytical and reasoning abilities. However, in many educational systems, including Pakistan's, traditional instructional approaches tend to prioritize factual recall over critical analysis. The National Education Policy (2009) and curriculum frameworks for science subjects emphasize the need for students to develop inquiry-based and problem-solving skills, yet the extent to which these objectives are realized in classroom practices remains uncertain. The Oxford English Dictionary defines critical thinking as "the process of thinking carefully about a subject or idea without allowing feelings or opinions to affect you." Critical thinking is the process of logical and intellectual deliberation that is focused on deciding what to accept or do.

Furthermore, critical thinking is a trained and self-coordinated form of reasoning that represents the pinnacle of reasoning appropriate to a particular mode (or region) of mind. Similar to this, critical thinking abilities are linked to complex brain functions like reasoning and problem-solving. Hitchcock (2018) described critical thinking as intentional, goal- directed thinking characterized by dispositional traits such as attentiveness, habit of inquiry, self-confidence, courage, open-mindedness, willingness to suspend judgment, trust in logic, and truth-seeking. Critical thinking (CT), which is regarded as one of the most crucial skills of the twenty-first century (Bialik & Fadel, 2015 & Wagner, 2014), appears to be the primary goal of science education in the current global era. This is so that students can deal effectively in all spheres of life. Because of its significance in every area of life, including information, technology, economics, and politics (Bailey & Mentz, 2015), this skill is regarded as being crucial for developing critical thinking skills (Higgins, 2015). De los Santos, O. (2025), scientific thinking promotes the development of critical thinking: implications for teacher practice.

In this era of "knowledge explosion," one must be able to critically assess information to use it effectively (Zhang & Kim, 2018). As it has become an essential component of growth and development, CT is also required for thinking about and acquiring information, which will improve learners' academic achievement and competency (Bialik & Fadel & 2015; Kules, 2016). Integrating critical thinking into science education can enhance students' ability to solve real-life problems. In an experimental study, Anat Zohar and colleagues assessed the analytical skills of 678 seventh-grade students before randomly selecting some to receive critical thinking instruction within their biology curriculum. After completing the program, students were re-evaluated, and those who had undergone critical thinking training demonstrated significant improvement in their analytical skills. Notably, their enhanced problem-solving abilities extended beyond biology-related tasks to everyday challenges (Zohar et al., 1994).

As a process CT is one of the skills of the twenty-first century and plays a significant role in science education. Through experimentation and observation, it is related to science education. The use of CT in scientific education has been discussed by several authors in various situations. For instance, Yacoubian (2015) believes that CT is the primary pillar of science education and that it helps future learners become more knowledgeable about science. According to Hagop A. Yacoubian (2015), there are various reasons for discussing Nature of Science (NOS) in science classes that are related to critical thinking. The promotion

of a greater understanding of the scientific subject matter is one reason for this, in addition to the humanization of the sciences and its placement in social, political, ethical, and cultural settings.

According to the aforementioned paper, critical thinking is a fundamental tenet for building a curriculum for learning about nature of science (NOS). Similar to this, the Next Generation Science Standards for the United States mandate that schools cultivate strong science competencies, including not just content-area expertise but also transferable abilities like critical thinking and (inquiry-based) problem-solving (National Research Council 2013). Similar to this, the present educational policies in Pakistan place a strong emphasis on helping pupils develop their critical thinking skills. For instance, the National Education Policy (Govt of Pakistan, 2009) and the

However, before exploring specific strategies for integrating critical thinking into science education, it is essential to recognize the importance of creating a classroom environment that encourages analytical reasoning and inquiry-based learning. The literature suggests multiple approaches to effectively promote critical thinking. Brookfield (2012) asserts that one of the most impactful ways for students to grasp critical thinking is by observing their teachers actively engage in it (p. 26). This study examines four key pedagogical strategies that form the foundation of the data analysis: classroom discussions, Socratic questioning, cooperative learning, and written assignments.

Statement of the Problem

Developing critical thinking among students is a quite difficult task because of traditional teaching strategies and the attitudes of teachers and students. Critical thinking is an important concept in the teaching-learning process for twenty-first- century students. Furthermore, international and national literature has emphasized the development of CT skills in secondary-level science students. Younis, N., Khan, Z., & Samina, (2022), Development of critical thinking skills of secondary school students through science curriculum: teachers' perceptions. Critical thinking among secondary students can help to strengthen the teaching- learning process. It is allegedly reported, also in the specific context of Pakistan that most of the secondary school teachers usually aimed at inculcating in their students to get good only grades for themselves implace of developing CT skills. While many teachers are eager to foster critical thinking, they often lack a clear understanding of the instructional steps required to cultivate these skills in the classroom. There is limited awareness among educators that their current pedagogical strategies and instructional techniques, both in classroom settings and everyday teaching practices, may not be adequate for enhancing higher-order cognitive skills. As a result, this practice hinders the development of a democratic society and results in poor learning, which is prevalent in Asian nations (Shaheen, 2012), as well as having significant negative personal, political, ethical, and cultural ramifications (Yacoubian, 2015). The following instructional strategies and techniques which help for the development of critical thinking, as they are Socratic questioning, classroom discussion, co-operative learning and written assignments. Though the acquiring of CT skill is precious yet one could hardly find any study that particularly focuses on the development or analysis of the skill in the context Pakistan in general and specifically in the context of Balochistan. The lack of critical thinking in the process of teaching and learning in secondary education can have some negative effects on students and teachers. Here are some ways in which this deficiency can affect the process of teaching and learning, such as surface-level learning, limited problem-solving skills, lack of analytical skills and dependence on memorization. In the modern world, where information is abundant and rapidly evolving, critical thinking is essential for students to navigate complex problems and make informed decisions. Despite its importance, critical thinking remains underdeveloped in many educational systems due to traditional rote-learning methods that prioritize memorization over analytical reasoning. The aims of the study to explore that to what extent science teachers are familiar with the concept of critical thinking and to what extent science teachers are practicing critical thinking development

strategies in their classrooms in secondary schools in Panjgur, Balochistan, regarding the teaching of critical thinking.

Objectives of the Study

The following are the objectives which guide the study:

1. To explore the perceptions of secondary school science teachers regarding teaching critical thinking in science in district Panjgur, Balochistan.

2. To explore the pedagogical practices employed by secondary school science teachers to promote critical thinking among science students in district Panjgur, Balochistan.

3. To explore the challenges faced by secondary school science teachers while implementing critical thinking in science education at district Panjgur, Balochistan.

Research Questions

Considering the above-mentioned research objectives, the following research questions are developed to guide the study:

1. What are the perceptions of secondary school science teachers regarding teaching critical thinking in science in district Panjgur, Balochistan?

2. What are the pedagogical practices employed by secondary school science teachers to promote critical thinking among science students in district Panjgur, Balochistan?

3. What are the challenges faced by secondary school science teachers while implementing critical thinking in science education at district Panjgur, Balochistan?

Significance of the Study

The current study benefits a variety of stakeholders, the study holds significance for a diverse range of stakeholders, including teachers, students, administrators, educationists, subject experts, policymakers, curriculum developers, teacher training institutions, future researchers, and society at large. By critically examining the development of critical thinking (CT) skills among secondary school students within the specific context of Panjgur, Balochistan, this research aims to provide valuable insights that can inform educational practices, policy decisions, and future studies.

Furthermore, the research will help identify perceived obstacles hindering the development of critical thinking in prospective teachers. This will enable the researcher to provide constructive feedback to authorities responsible for designing teacher education programs, assisting them in addressing these barriers effectively.Lastly, the study will play a crucial role in identifying gaps between teacher educators' theoretical understanding of critical thinking and their actual classroom practices for developing critical thinking skills.

METHODOLOGY

This study employed a qualitative research approach with a case study research design to explore the Teaching Critical Thinking in Science: Perceptions and Practices of Secondary School Science Teachers in Panjgur, Balochistan. According to Creswell (2014), the goal of qualitative research is to explore any phenomenon that exists in the social environment and how it is formed, experienced, and interpreted. The target population for this study comprised twenty four (24) male secondary schools in district Panjgur. A purposive sampling technique is used to select a sample size (n) of 15 teachers from the 8 selected schools out of the 24 (=N) male secondary schools. Data were collected through semi-structured interviews as the primary data collection method. Thematic data analysis method used to analyze the data. This method includes three steps which are converting all data into readable form, generating sub themes and integrating the themes to consolidate findings. In addition, all data analyzed in light of research objectives and questions.

RESULT

Demographic Profile of the Participants

The demographic profile of the 15 secondary school science teachers in this study includes key characteristics such as age, gender, teaching experience, educational qualifications, and school type public. The participants were selected from various secondary schools in Panjgur, Balochistan, ensuring a diverse representation of teaching backgrounds. Most participants had over five years of teaching experience, allowing them to provide valuable insights into pedagogical practices and challenges related to teaching critical thinking. The sample also included teachers with varying academic qualifications, ranging from bachelor's degrees in science education to master's degrees in their respective disciplines.

Table 1

Teachers number	Age	Gender	Profession	Length of service	Institution	Date of Interview
1	45	Male	Science Teacher	20	Public school	05, October, 2024
2	38	Male	Science Teacher	14	Public school	07, October, 2024
3	36	Male	Science Teacher	09	Public school	09, October, 2024
4	40	Male	Science Teacher	16	Public school	11, October, 2024
5	35	Male	Science Teacher	06	Public school	12, October, 2024
6	32	Male	Science Teacher	04	Public school	15, October, 2024

7	34	Male	Science Teacher	07	Public school	17, October 2024
8	35	Male	Science Teacher	07	Public school	20, October, 2024
9	37	Male	Science Teacher	13	Public school	22, October, 2024
10	34	Male	Science Teacher	05	Public school	24, October,2024
11	48	Male	Science Teacher	26	Public school	27, October,2024
12	36	Male	Science Teacher	14	Public school	29, October,2024
13	35	Male	Science Teacher	12	Public school	01, November, 2024
14	41	Male	Science Teacher	17	Public school	03, November, 2024
15	30	Male	Science	07	Public school	05, November, 2024

Teachers Number: This refers to a unique numerical identifier assigned to each teacher in the dataset. It helps differentiate individuals and maintain organization in the research data. The above table shows chronological age of each research participant in years. It is an important demographic variable that can indicate levels of experience and potential generational perspectives on teaching. This denotes the biological sex of the teachers in the dataset. Understanding gender distribution can provide insights into the teaching workforce composition in science education. Profession: This describes the occupation of the respondents. In this dataset, all participants are science teachers, which highlights their specialization in the education sector. Length of Service: This indicates the total number of years a teacher has been working in their profession. It is an essential variable for analyzing teaching experience, expertise, and professional growth over time.

Thematic Map of the Study

Table 2

Main Themes Of The Study				
Perceptions of	Pedagogical	Challenges in	Institutional	Strategies to
Science Teachers	Practices to	Implementing	Support and the	Overcome

about Critical	Promote Critical	Critical Thinking	Role of School	Barriers and
Thinking in	Thinking	in Science	Administration	Enhance Critical
Science Education		Education		Thinking
Each Main Theme Has 3 Sub-Themes				
Science Teachers	Inquiry-Based	Lack of	School Policies	Teacher Training
Understanding of	and Problem-	Resources and	and Prioritization	and Capacity
Critical Thinking	Solving	Infrastructure	of Critical	Building
	Approaches		Thinking	
Importance of	Use of	Time Constraints	Teacher Training	Use of Modern
Critical Thinking	Experiments and	and Curriculum	and Professional	Technology and
in Science	Hands-on	Overload	Development	Interactive Tools
	Learning			
Role of Critical	Integration of	Student	Need for	Encouraging a
Thinking in	Technology and	Engagement and	Curriculum	Collaborative and
Student	Creative	Learning	Reforms and	Inquiry-Based
Development	Teaching	Difficulties	Structural	Learning
	Methods		Changes	Environment

Main Theme Perceptions of Science Teachers about Critical Thinking in Science Education

The main theme refers to teachers' beliefs, understandings, and attitudes regarding the importance of developing students' analytical and problem-solving skills in science. It includes their views on how critical thinking enhances scientific inquiry and decision-making. These perceptions influence their teaching methods, classroom activities, and approaches to fostering student engagement in scientific reasoning.

Sub-Theme: Science Teachers Understanding of Critical Thinking

Teacher participant described that critical thinking as a dynamic and multidimensional process that involves looking at problems from various perspectives. His views highlight the importance of questioning, exploring multiple angles, and making informed efforts to find the best possible solution. In addition, interviewee's view aligns with an inquiry-based learning approach, where students actively participate in discussions, evaluate different viewpoints, and develop problem- solving skills, narrated in the following statement:

Critical thinking is defined as when anybody faces a problem or situation, looks at it from many angles, has discussions, considers analysis from multiple perspectives, and makes efforts for its solution. (Interviewee Participant 1)

Teacher participant emphasized the multifaceted nature of critical thinking. Respondents repeatedly highlight the importance of looking at a situation from all perspectives, discussing and analyzing various angles to find the best possible solution. Critical thinking is seen as a dynamic process that encourages deeper investigation into the root cause of issues rather than accepting surface-level answers. Another participant shared:

Critical thinking is the ability to analyze, evaluate, and synthesize information objectively to make reasoned judgments and decisions. (Interviewee Participant 4)

Teacher participant definition outlined the process of critical thinking as both evaluative and analytical, underscoring that critical thinking is not just about generating ideas but also about assessing them to make balanced, informed judgments:

Critical thinking means thinking carefully and clearly. It involves analyzing information, questioning ideas, and making decisions based on facts, not just emotions or opinions. (Interviewee Participant 5)

Main-theme: Pedagogical Practices to Promote Critical Thinking

This theme refers to the teaching strategies and methods used by science teachers to develop students' analytical, reasoning, and problem-solving skills. These practices include inquiry-based learning, project-based activities, classroom discussions, and hands-on experiments. The aim is to engage students in questioning, analyzing, and applying scientific concepts to real-world situations.

Sub-theme: Inquiry-Based and Problem-Solving Approaches

Teacher participant revealed an intentional and interactive approach to fostering student learning. The use of the "inquiry teaching technique" indicates a student- centered pedagogical strategy where learning is driven by students' questions, exploration, and active participation. This approach aligns with critical thinking as it allows students to explore concepts in greater depth and draw their own conclusions based on evidence and reasoning.

In my classroom, I use the inquiry teaching technique. I conduct question- answering sessions to help students understand the depth of a task. (Interviewee Participant 1)Teacher participant presented a strong argument against rote memorization and passive learning in favor of fostering independent, critical thinkers. The comparison to "robots" implies a concern that, without critical thinking, students might become mechanical in their learning—simply following instructions or procedures without understanding the underlying concepts.

Critical thinking should be encouraged so that students do not become like robots that need keys for doing things. They should have a thirst for knowledge and be self-learners. (Interviewee Participant 2)

Main-theme: Challenges in Implementing Critical Thinking in Science Education

This theme refers to the obstacles science teachers face when promoting analytical and problem- solving skills in students. These challenges may include a lack of resources, large class sizes,

rigid curricula, and insufficient teacher training. Additionally, cultural expectations and assessment methods that prioritize rote learning over critical thinking can hinder effective implementation.

Sub-theme: Lack of Resources and Infrastructure

Teacher participant underscored a significant barrier to effective science education. The lack of science tools, teaching kits, and basic facilities in the classroom highlights the resource limitations that hinder both teaching and learning. These tools are crucial for creating an interactive, hands-on learning environment, where students can directly engage with scientific concepts and conduct experiments.

We don't have the science tools, teaching kits, and well-prepared classrooms with basic facilities. (Interviewee Participant 2)

Teacher participant highlighted the significant challenge posed by the absence of essential materials and modern equipment in science education. These resources are critical for enabling hands-on activities, which are central to scientific learning and inquiry. Without science kits and modern equipment, students are unable to engage in practical experiments, which are key to fostering skills such as problem-solving, critical thinking, and scientific investigation.

The main challenge is a lack of materials, science kits, and modern equipment, which makes it difficult to conduct hands-on activities. (Interviewee Participant 10)

Main-theme: Institutional Support and the Role of School Administration

This theme refers to the guidance, resources, and policies provided by schools to help teachers implement critical thinking in science education. This support includes professional development programs, provision of teaching materials, and creating a collaborative learning environment.

Effective school leadership plays a key role in fostering a culture that values innovation, inquiry- based learning, and continuous improvement in teaching practices.

Sub-theme: School Policies and Prioritization of Critical Thinking

Teacher participant highlighted the disconnection between the current educational focus and the potential for creative thinking among students, which could be harnessed to foster critical thinking. While students demonstrate creativity in non-academic areas like poetry, dance, and sports, the lack of a critical thinking emphasis in the school curriculum limits their ability to apply these creative skills in more analytical and evaluative contexts.

There is no specific critical thinking priority in our school, but many students have creative thoughts in poetry, dance, singing, and sports. (Interviewee Participant 2)Teacher participant underscored the lack of institutional support for the development of critical thinking within the school environment. This situation

highlights several key challenges faced by teachers when trying to integrate critical thinking into their teaching practices. The lack of a structured plan and resources for promoting critical thinking in the school is a significant barrier to its effective implementation. For critical thinking to become a core part of the school's teaching practices, there must be a systematic, school-wide effort to provide both the necessary resources and the professional support needed to integrate these skills into all aspects of learning.

The school administration does not provide any structured plan or resources to promote critical thinking, which makes it difficult for teachers to implement it effectively. (Interviewee Participant 7)

Main-theme: Strategies to Overcome Barriers and Enhance Critical Thinking

This theme explores effective strategies that science teachers use to overcome barriers in teaching critical thinking. It includes adapting instructional methods, integrating technology, using inquiry-based learning, and fostering a classroom culture that encourages questioning and discussion. By addressing challenges such as resource limitations and rigid curricula, teachers can create engaging learning environments that enhance students' critical thinking skills. The main theme has three sub-themes as given.

Sub-theme: Teacher Training and Capacity Building

Teacher participant emphasizes the crucial role of teacher training and capacity- building in effectively integrating critical thinking into science education. Participant statement highlights the urgent need for ongoing teacher training to enhance critical thinking in science education. Without professional development and continuous learning opportunities, teachers will struggle to shift away from rote learning.

We need professional development workshops and continuous training for teachers on critical thinking methods. (Interviewee Participant 5)

Teacher participant described the responsibility of educational authorities in ensuring that teachers are equipped with the latest teaching methodologies to foster critical thinking in science education. Participant statement highlights the critical need for government and higher education institutions to take an active role in teacher training. Without up-to-date training sessions, teachers may struggle to implement modern critical thinking strategies in science education.

The government and higher education institutions should take steps to provide up-to-date training sessions for teachers. (Interviewee Participant 8)

DISCUSSION

This chapter provides an in-depth discussion of the findings from the study on Teaching Critical Thinking in Science: Perceptions and Practices of Secondary School Science Teachers in Panjgur, Balochistan. The chapter examines how teachers perceive critical thinking, the pedagogical strategies they employ to foster it, and the challenges they encounter. These findings are analyzed in light of existing literature to draw meaningful conclusions and implications for science education.

The findings of this study reveal that secondary school science teachers in Panjgur generally perceive critical thinking (CT) as a cognitive process involving analysis, questioning, and informed decision-making. Many participants viewed CT as a form of problem-solving that enables students to evaluate issues from multiple perspectives and generate logical solutions.

This understanding aligns with Hitchcock (2018), who defines CT as an evaluative and analytical process requiring sound reasoning. Similarly, Yacoubian (2015) emphasized that CT is indispensable in science education because it cultivates deeper conceptual understanding and helps students move beyond rote memorization. Recent research by Lu and Xie (2024) and Meza et al. (2024) also supports this view, highlighting that explicit CT instruction prepares learners for the demands of the 21st century. Another significant finding concerns teachers' inconsistent understanding of CT components. Some participants described CT as synonymous with problem- solving, while others linked it to knowledge acquisition. Such conceptual ambiguity indicates a lack of clear pedagogical grounding, echoing findings from Demir (2015) and Bibi (2023), who observed that teachers often struggle to define CT coherently in the absence of formal training. This underscores the need for targeted professional development programs that help teachers understand CT as both a process and a disposition, and guide them in designing lessons that explicitly nurture these competencies.

Teachers in this study frequently reported using classroom discussions and Socratic questioning to encourage students' critical engagement. They perceived these strategies as valuable for stimulating reasoning, challenging viewpoints, and refining students' thought processes. This finding supports Paul and Elder's (2006) argument that systematic questioning is at the heart of CT development. Similarly, a study by Arifin (2025) found that structured questioning frameworks significantly improved students' analytical performance in science classes. However, many participants acknowledged that their classroom discussions were not always well-structured to maximize critical engagement. While students were encouraged to share opinions, they were seldom guided to evaluate evidence or construct logical arguments. This observation aligns with Williams (2005) and recent work by Sam (2024), who assert that the effectiveness of discussion-based pedagogy depends on intentional scaffolding that prompts students to justify claims, examine evidence, and integrate multiple perspectives.

Recent meta-analyses confirm that inquiry-based and problem-based learning substantially improve CT outcomes when teachers are well-prepared and assessments are aligned with higher- order skills (Arifin, 2025; Sam, 2024). Despite this recognition, some teachers in Panjgur struggled to implement inquiry-based lessons effectively due to curriculum rigidity, time constraints, and limited training. These systemic barriers mirror challenges reported in other low- resource contexts (Lu, 2024; Jamil, 2024), highlighting the need for contextualized inquiry models adaptable to local classroom realities.

Teachers also identified group activities and project-based learning as effective tools for promoting CT. They observed that collaboration encourages students to exchange ideas, justify reasoning, and appreciate diverse perspectives. This finding aligns with Slavin (2011), who emphasized that cooperative learning fosters CT by promoting dialogue and accountability. Similar outcomes were reported by Younis (2022), who found that structured group work significantly improved Pakistani students' reasoning and problem-solving abilities. However, teachers in this study noted unequal participation in group tasks, indicating the need for well- designed cooperative structures that ensure equitable engagement and accountability among all learners. One of the most pressing challenges highlighted was the lack of professional training on CT pedagogy. Many participants admitted they had never received formal instruction on integrating CT into their teaching. This finding is consistent with Demir (2015) and Ahmad (2025), who identified inadequate teacher preparation as a critical obstacle to CT implementation. Without explicit pedagogical guidance, teachers tend to rely on traditional, content-driven approaches that hinder higher-order thinking. The curriculum and examination

system also emerged as major barriers. Teachers expressed concern that the current system prioritizes factual recall over reasoning and inquiry. This resonates with Shaheen's (2012) critique of examination-driven education systems in South Asia that discourage CT practices. Contemporary evidence (Neupane, 2024; Lu & Xie, 2024) reinforces that when assessment frameworks emphasize memorization, teachers are

disincentivized from adopting inquiry or reasoning-based instruction. Furthermore, resource constraints—such as lack of laboratory facilities, multimedia tools, and science kits—were widely reported, limiting teachers' ability to implement hands-on inquiry. These findings corroborate Yacoubian's (2015) and Bibi's (2023) conclusions that inadequate resources severely restrict opportunities for experiential learning and CT development.

Overall, this study's findings align with the international consensus that teacher beliefs, professional competence, and contextual conditions jointly determine the successful integration of CT in science education (Arifin, 2025; Sam, 2024; Jamil, 2024). The observed perception– practice gap reflects the model proposed by Brookfield (2012), who argued that without continuous reflection and institutional support, teachers' awareness of CT seldom translates into transformative practice. The findings also validate constructivist learning theory, which posits that students develop CT when they actively construct knowledge through inquiry, collaboration, and reflection (Vygotsky, 1978; Piaget, 1972).

1. The study concludes that while science teachers in Panjgur hold positive perceptions of CT and recognize its relevance to science education, their classroom practices remain limited and inconsistent. The main outcomes can be summarized as follows:

1. Conceptual Outcome: Teachers possess a partial understanding of CT, viewing it mainly as a cognitive skill rather than a broader intellectual disposition.

2. 2. Pedagogical Outcome: Teachers employ discussion, questioning, and inquiry-based strategies, but their implementation often lacks structure and depth.

3. Systemic Outcome: The integration of CT is constrained by examination-oriented curricula, insufficient professional development, and inadequate teaching resources.

4. Practical Outcome: There is an urgent need for structured, context-sensitive professional training programs, aligned assessments, and resource support to enable teachers to effectively cultivate CT in science classrooms.

In essence, the findings highlight a perception–practice gap: teachers value CT but struggle to translate this understanding into practice due to systemic and pedagogical limitations. Addressing these barriers through sustained professional development and curricular reforms could significantly enhance science teaching and learning outcomes in Balochistan.

CONCLUSION

This study highlights the crucial role of secondary school science teachers in fostering critical thinking among students in Panjgur, Balochistan. While teachers recognize its importance, their understanding is often limited to problem-solving rather than broader analytical skills. Despite employing strategies like Socratic questioning, inquiry-based learning, and cooperative discussions, systemic barriers— such as a rigid curriculum, exam-focused assessments, lack of professional development, and resource constraints—hinder effective implementation. However, teacher's express willingness to adopt critical thinking strategies if provided with adequate training and institutional support.

The study's findings indicated that many science teachers lacked familiarity with the concept of critical thinking. However, teachers who had received training on critical thinking demonstrated a stronger understanding compared to those without such training. Overall, while science teachers occasionally implement strategies to develop critical thinking in their classrooms, its application remains inconsistent.

Addressing these challenges through professional development, curriculum and assessment reforms, and improved resource allocation will be essential in ensuring that students develop the critical thinking skills necessary for scientific literacy and real-world problem-solving. By bridging the gap between theoretical knowledge and practical application, science education in Panjgur, Balochistan, can be transformed to produce independent, analytical thinkers who are prepared for academic and professional success.

However, the study also highlights several challenges faced by teachers in implementing critical thinking in their classrooms. Limited resources, insufficient teacher training, and curriculum constraints emerged as significant barriers. Teachers reported a lack of access to technological tools and materials that could support inquiry-based learning and interactive teaching methods. The study also calls for future research to include broader perspectives, such as those of students and female teachers, and to explore innovative approaches to overcoming the barriers to teaching critical thinking. By addressing these challenges, critical thinking can become a cornerstone of education, enabling students and teachers alike to contribute meaningfully to their communities and society at large.

RECOMMENDATIONS

Based on the data collected from the analysis, the following recommendations are made.

1. Teacher Training Programs: There is a need for targeted professional development programs that equip teachers with effective strategies for fostering critical thinking in science education.

2. Curriculum Reform: The science curriculum should be restructured to incorporate more inquiry-based learning and critical thinking activities rather than prioritizing rote memorization.

3. Assessment Reforms: Examination systems should be revised to include open- ended, application-based questions that assess students' reasoning and problem- solving abilities.

4. Resource Allocation: Schools must be equipped with adequate resources, such as laboratory facilities and multimedia tools, to support hands-on and inquiry-based learning.

5. Classroom Strategies: Teachers should be trained to implement structured cooperative learning and discussion techniques that ensure active participation and deeper engagement from students.

6. Teachers should receive regular training and refresher courses on pedagogical strategies that foster CT skills development. Master trainers should ensure training programs

7. emphasize the importance of CT and equip teachers with practical tools for implementation.

8. Monitoring systems should shift focus from administrative tasks (e.g., cleanliness, enrollment) to the quality of education, specifically CT skills development.

9. Educational officers should inspect and ensure the implementation of pedagogical approaches that promote CT skills as outlined in policy documents. The education department should motivate and appreciate teachers actively working to enhance CT skills among students.

10. Engage parents and community stakeholders in understanding the importance of critical thinking for students' future success. Schools should organize seminars and sessions to create awareness about the benefits of this skill in education and beyond.

Advocate for government and education authorities to prioritize critical thinking in science education. Develop policies and frameworks that align teacher training, curriculum design, and assessment with this goal. Address local challenges such as limited resources, overcrowded classrooms, and traditional teaching mindsets. Provide support in the form of funding, teacher incentives, and a gradual shift from rote learning to critical thinking pedagogy.

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