

Reflection of 21st-century Skills in Bangladesh's Education Policy, Junior Secondary Science Curriculum and Teacher Curriculum Guides: Their Implementation in Classrooms

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Abstract

Science remains a vital subject in the 21st century. This study examines which 21st-century skills are integrated into the Education Policy, Junior Secondary Science Curriculum, and Teacher Curriculum Guide documents in Science education, how these skills align with CPD and P21 international frameworks, and how teachers implement them in junior secondary science classrooms. The study also examines the challenges teachers face in teaching these skills. This qualitative study involved 9 science teachers, 45 students, and 2 experts. Data were gathered through document analysis, classroom observations, focus groups, and interviews with teachers and experts, and then analyzed thematically. The education policy, junior secondary science curriculum, and teacher curriculum guide included skills such as critical thinking, problem-solving, collaboration, communication, creativity, leadership, and ICT literacy, and were aligned with international frameworks. Teachers frequently practiced critical thinking, communication, and creativity, but few involved students in problem-solving or ICT activities. Common challenges include large class sizes, inattentive students, insufficient multimedia resources, low student interest in leadership, and limited student ability to respond to critical and creative questions barriers that hinder effective teaching of 21st-century skills.

Keywords: 21st-century skills, Science education, Science classroom, Teaching learning practice, Teaching challenges

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1. Introduction

To stay competitive today, students must develop skills such as critical thinking, digital literacy, and problem-solving, as emphasized by the Ministry of Education (2010) and organizations such as the Partnership for 21st Century Skills. The British Council's (CPD) Framework also recommends these to improve student growth. These skills address global challenges such as climate change and technological advances. Science education promotes creativity, inquiry, and life skills beyond memorization. Integrating these skills into science curricula is vital for students to utilize new technology, solve

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problems, and contribute to society. This study examines how these skills are reflected in Bangladesh's education policy, junior secondary science curriculum, and teacher curriculum guide, focusing on teaching practices and teachers' challenges in implementing them in junior secondary science classrooms.

1.1 Research Problem

21st-century skills and science education are linked, with science fostering critical thinking, creativity, and problem-solving (Fazzino, 2017; National Curriculum and Textbook Board [NCTB], 2017). Education has shifted from memorization-based curricula to align with the job market and future careers (Fazzino, 2017; Windschitl, 2009, as cited in Abualrob, 2019). Learning by doing promotes creativity (NCTB, 2017). The NCTB-2012 policy emphasizes inquiry-based and creative skills to meet modern challenges and employment needs. Teachers should align strategies with market needs (Abualrob, 2019). Science teaching should focus on inquiry and activities to develop skills. A lack of 21st-century skills signals poor education and adaptation issues; thus, curricula and education policy must incorporate these skills (Abualrob, 2019). Implementing new skills requires clear guidance and materials, which are currently lacking.

1.2 Research Questions

- a. According to internationally suggested frameworks, what 21st-century skills are reflected in the
- b. Education Policy, Junior Secondary Science Curriculum, and Teacher Curriculum Guide of Bangladesh?
- c. What are the strategies teachers use to implement 21st-century skills in science classrooms?
- d. What are the challenges teachers face during the practice of 21st-century skills in science classrooms?

2. 21st-Century Skills Regarding Science Education

Science education aims to develop students' knowledge, talent, and creativity to an international standard, making it crucial to incorporate 21st-century skills (Abualrob, 2019). It should engage students in thinking, imagination, and inquiry rather than rote memorization, helping them understand subjects deeply and solve real-world problems (Ministry of Education, 2010). Inquiry-based learning and scientific thinking foster critical thinking, creativity, and problem-solving skills, enabling students to apply knowledge in new situations (NCTB, 2017). Practicing scientific processes enhances creativity and critical thinking (National Curriculum and Textbook Board [NCTB], 2012; NCTB, 2017).

2.1 Critical Thinking and Problem Solving

Marita Turpin emphasizes critical thinking and problem-solving as essential for future challenges. The Partnership for 21st Century Learning (2010) highlights that critical thinking involves analyzing, evaluating, and connecting information, as well as reflecting

on learning. Science education should foster thinking, imagination, and inquiry over memorization to help students qualify. Textbooks should be designed to help students understand concepts, solve problems, and apply knowledge in practice (Ministry of Education, 2010).

2.2 Collaboration and Communication

Student-teacher collaboration fosters leadership, teamwork, and communication skills (NCTB, 2012). Students learn from peers via constructivist activities. Communication skills oral, written, nonverbal help student's articulate ideas (Partnership for 21st Century Learning, 2010). Abualrob (2019) advocates open collaboration to improve communication and innovation. However, Ha Le et al. (2018) note challenges, such as low student interest in teamwork.

2.3 Creativity

Science education aims to develop students' knowledge, talent, and creativity to an international standard (Ministry of Education, 2010). Teachers should possess qualities such as personality, creativity, and leadership suitable for the classroom (NCTB, 2017). Teaching in science should be creative, using thought-provoking questions and activities to foster creativity and skills (NCTB, 2012; NCTB, 2017). Johnson (2019) advocates for teachers to design activities that encourage exploration. However, Babu (2016) notes that Bangladeshi science teachers tend to focus more on asking creative questions instead of organizing hands-on activities.

2.4 Leadership

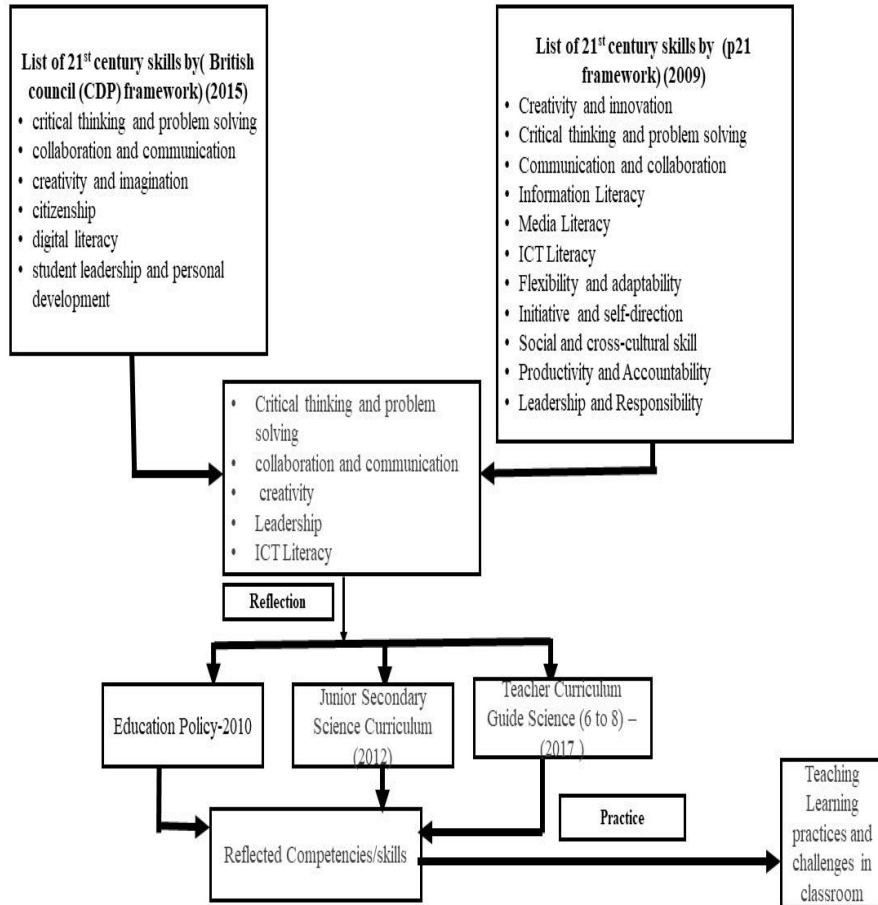
Guide and lead others using interpersonal and problem-solving skills to influence towards a goal (Partnership for 21st Century Learning, 2010). Leadership is valued in the curriculum, especially within emotional values, and is developed through collaborative teaching. Teachers should cultivate personality, creativity, and leadership suited for their classes (NCTB, 2017; NCTB, 2012). Leadership skills grow when leaders effectively talk and listen in group work (NCTB, 2012). Fulton (2019) asserts that group projects are an excellent leadership practice.

2.5 ICT Literacy

ICT involves collecting data using technology (Partnership for 21st Century Learning, 2010) and is essential to the development of Digital Bangladesh across all education sectors (Ministry of Education, 2010). The Teacher Curriculum Guide outlines integration methods that require teachers to develop technological skills. Policies aim to foster environments where students use modern technology to boost interest, confidence, productivity, and creativity (NCTB, 2017; NCTB, 2012). However, many teachers still prefer traditional methods and have not fully adopted ICT (Jones, 2001; Raman & Yamat, 2014).

2.6 Conceptual Framework

The conceptual framework, developed from the literature review, also considers document analysis to identify 21st-century skills.

Figure 1*Conceptual Framework***3. Research Methodology**

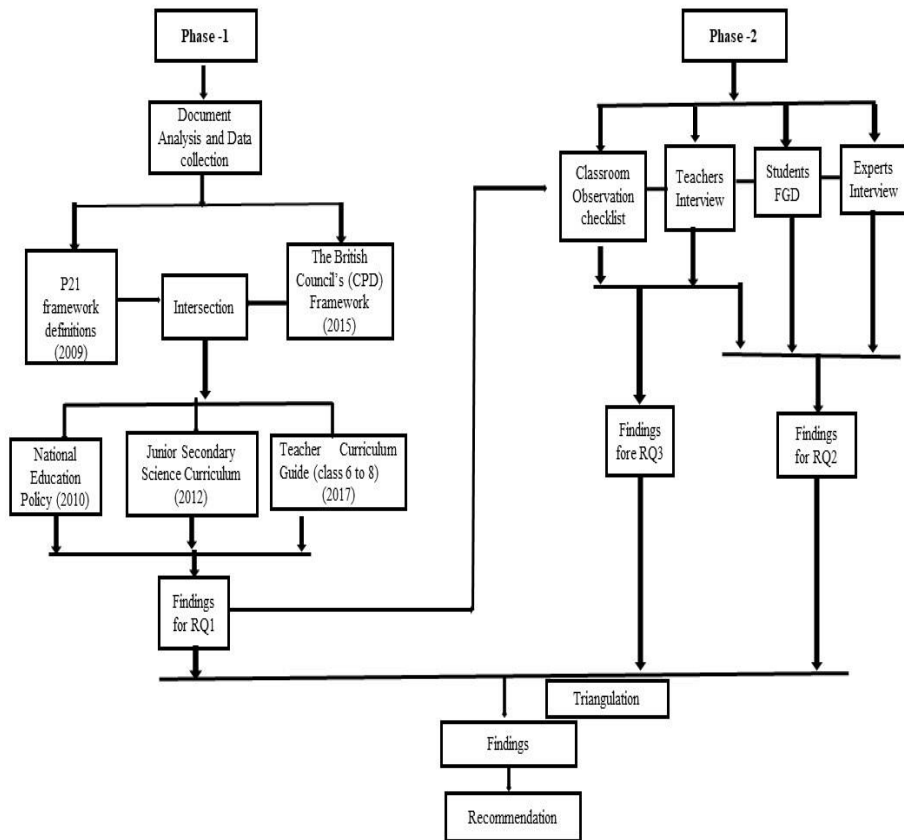
The study explores how 21st-century skills are reflected in Bangladesh's education policy, junior secondary science curriculum, and teacher curriculum guide; how teachers practice them in the teaching-learning process and the challenges they face during classroom implementation. All questions are exploratory. Creswell (2012) states that qualitative research is well-suited to understanding central phenomena in depth.

3.1 Data Source

Data Sources for this study are-

- British Council (CPD) framework (2015)
- P21 framework

- Education policy of Bangladesh (2010) / (Ministry of Education, 2010)
- Secondary Science Curriculum of Bangladesh (2012)/ (NCTB, 2012)
- Teacher Curriculum Guide (2017) (classes 6-8)/ (NCTB,2017)
- Junior secondary science classroom observations (9 classes, grades 6-8)
- Junior secondary science teachers
- Junior secondary science students
- Curriculum Experts

Figure 2*Research Design*

3.2 Sample Size and Sampling Technique

The study included nine junior secondary science teachers and forty-five students from

three different schools (public, private, and MPO-affiliated) in Dhaka City. The study purposively and conveniently selected three junior secondary science teachers and five students from each teacher's classroom from each school (Creswell, 2012). The study also selected two curriculum experts.

3.3 Data Collection Tools

This study employed five data collection tools. To address RQ1, (a) document analysis was conducted. For RQ2 and RQ3, the following methods were used: (b) a semi-structured classroom observation checklist, (c) students' focus group discussions (FGD), (d) a teacher interview schedule, and (e) an interview with an expert. The researcher designed these questionnaires using previous research publications, Bangladesh's education policy (2010), the junior secondary science curriculum (2012), and the teacher curriculum guide (2017).

3.4 Data Analysis

The researcher gathered qualitative data from classroom observation checklists, student FGDs, and interviews with teachers and experts. She conducted thematic analysis following Braun and Clarke's (2006) six-step method. First, she repeatedly reviewed interview and FGD responses and observation notes, identifying comments related to classroom practices and teacher challenges. Second, she generated initial codes from responses concerning classroom activities, teaching strategies, and difficulties faced, assigning codes across participants and sources for comparison. In the third step, related codes were grouped into categories and themes, with supplementary codes added from responses and observations to explore new ideas. The fourth step involved reviewing and comparing potential themes, examining their similarities and differences, and reorganizing them for clarity. In the fifth step, she defined and labeled the themes and compared responses among students, teachers, and experts. Finally, she used these themes to answer research questions, illustrating how teachers implemented 21st-century skills and the challenges encountered. Codes based on 21st-century skills from document analysis guided the process, with additional data enriching the framework. Broader themes emerged from similar codes, supporting hypothesis development and insight generation. The analysis focused on 21st-century skills from document review, but also integrated new ideas and data from observations, interviews, and FGDs, supporting triangulation and strengthening findings. The researcher noted that her classroom presence may have affected practices and responses. Responses.

3.5 Ethical Consideration

A qualitative researcher must protect participants' identities during recruitment and data sharing (Arifin, 2018). Before data collection, the researcher secured approval from school authorities and participants. All participated voluntarily and gave informed consent before class observations and audio-recorded interviews. The researcher set ground rules for confidentiality before the focus group discussion. Participants were assured that names, organizations, and roles would remain confidential and that the data would be used solely for research. Only quotes served as data.

4. Analysis of Data and Results

4.1 Reflection of 21st-Century Skills

This section analyzes the data for research question 1 via document review. The first two documents. The British Council's Continuing Professional Development (CPD) (2015) and Partnership for 21st Century Skills (P21) 2009) were examined to identify common 21st-century skills in education.

Table 1

CPD and P21 recommended 21st century skills

British Council's Continuing Professional Development (CPD) (2015)	Partnership for 21st Century Skills (2009)
Critical thinking and problem solving	Creativity and innovation
Collaboration and communication	Critical thinking and problem solving
Creativity and imagination	Communication and collaboration
Citizenship	Information Literacy
Digital literacy	Media Literacy
Student leadership and personal development	ICT Literacy
	Flexibility and adaptability
	Initiative and self-direction
	Social and cross-cultural skills
	Productivity and Accountability
	Leadership and Responsibility

As shown in Table 1, CPD and P21 both suggested common 21st-century skills: critical thinking, problem-solving, collaboration, communication, creativity, leadership, and ICT literacy.

Table 2

The Education Policy 2010, Secondary Science Curriculum 2012, and Teacher Curriculum Guide (6 to 8) (2017) were analyzed to identify the 21st-century skills reflected.

Skills	Education Policy (2010) (times) (Ministry of Education, 2010)	Secondary Science Curriculum (2012) (times) (NCTB, 2012)	Teacher Curriculum Guide (class 6 to 8) (2017) (times) (NCTB, 2017)
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Critical thinking	1	6	5
Problem solving	1	6	6
Collaboration		1	1
Communication		1	1
Creativity	1	7	10
Leadership		3	2
ICT Literacy	2	2	4

Table 2 three documents the Education Policy (2010), Secondary Science Curriculum (2012), and Teacher Curriculum Guide (6 to 8) (2017) were analyzed, and these documents include the common 21st-century skills found in CPD and P21. To identify how many times these skills are mentioned in these three documents, tally marks are used.

This shows that the education policy primarily focuses on ICT literacy. The secondary Science Curriculum and Teacher Curriculum Guide both primarily focus on creative, critical-thinking, and problem-solving skills.

Analyzing both tables (1 & 2) revealed that these common 21st-century skills critical thinking and problem-solving, collaboration and communication, creativity, leadership, and ICT literacy are reflected across the five documents. Therefore, developing these skills is essential in science education.

- **Critical Thinking and Problem-Solving:** Science enhance students' critical thinking, creativity, and problem-solving skills, enabling them to apply their knowledge to new situations (NCTB, 2017). A key goal of education is to develop logical thinkers through overall growth (NCTB, 2012). Textbooks should be designed so that students understand science subjects, solve problems, and apply knowledge in real life. (Ministry of Education, 2010) Students should receive homework that fosters critical thinking and creativity through problem-solving tasks and inquiry-based learning. Scientific approaches and experiments help develop these skills. (NCTB, 2017)
- **Collaboration and Communication:** Collaboration is a key value in the curriculum's emotional domain. It helps develop students' collaboration, communication, and leadership skills. (NCTB, 2017; NCTB, 2012).
- **Creativity:** Science education aims to develop students' knowledge, talent, and creativity to international standards (Ministry of Education, 2010). Teachers should have the personality, creativity, and leadership qualities suited to the classroom. Creativity is essential for teachers (NCTB, 2017), as science teaching should be thought-provoking and promote creativity and skills (NCTB, 2012; NCTB, 2017). Each lesson should include at least one creative question or task, with homework that fosters critical thinking and creativity (NCTB, 2017). The previous curriculum

lacked scope for inquiry-based, problem-solving, hands-on, creative, and productive skills (NCTB, 2012). Curricula should offer space for inquiry-based, creative, and productive skill development (NCTB, 2012). Science enhances critical thinking, creativity, and problem-solving skills, with hands-on learning increasing creativity (NCTB, 2017). Scientific methods help develop these skills (NCTB, 2012; NCTB, 2017).

- **Leadership:** Leadership is a key emotional value to include in the curriculum. Students develop it through collaborative work. Teachers should have qualities like personality, creativity, and leadership suitable for their classes (NCTB, 2017; NCTB, 2012). Leadership qualities grow when leaders know how to communicate and listen in group settings (NCTB, 2012).
- **ICT Literacy:** ICT education closely relates to science education and complements it. To develop Digital Bangladesh, ICT must be integrated across all education sectors (Ministry of Education, 2010). Teachers should have the skills to use teaching and technological aids and create an environment for students to learn modern technology. Developing students' interest in ICT enhances their confidence, productivity, and creativity (NCTB, 2017; NCTB, 2012). ICT also supports inquiry-based learning.

4.2 Strategies Teachers Used to Implement 21st-Century Skills in Science Classrooms

This section analyzes data from research question 2, collected through observations, interviews with teachers and experts, and focus groups, to examine junior secondary science teachers' teaching – learning practices in science classrooms related to 21st-century skills. The analysis involved four steps: (1) identifying a major theme, (2) identifying six minor themes, (3) collapsing minor themes into sub-themes, and (4) analyzing minor themes within sub-themes.

Classroom setup, teacher's role, and practice influenced how junior secondary science teachers teach 21st-century skills. Teachers' practices related to these skills also affected some factors. These factors include -

A. 21st-Century Skills

Most students were initially unfamiliar with 21st-century skills. After the researcher's explanation, they recognized them. Some students associated them with computers, ICT, or creativity. Many focused on communication and devices. A student from MPO defined these skills as communication, computer use, and information sharing. A government school student linked computer use to education, and another emphasized phones and computers. Most of the teachers find it difficult to recognize these skills but agree that digital devices and ICT are essential for science education. A trained teacher from a non-government school highlighted the role of ICT and multimedia in understanding topics, while another MPO teacher stressed their importance during the pandemic. A government teacher noted reliance on technology as key to national growth.

B. Critical Thinking and Problem Solving

Table 3

Teachers' teaching-learning practices in science classes, practices mentioned in the secondary science curriculum and Teacher Curriculum Guide, and expert opinion regarding critical thinking and problem solving

Teachers' Practice in the Science Classes	Mention Practices in the Secondary Science Curriculum & Teacher Curriculum Guide.	Expert Opinion
Asked thoughtful, short verbal questions	Need to develop a scientific approach and qualification	Practice of decision making
Assign classwork	Applying their acquired knowledge in a new situation	Inquiry-based learning
Assign homework	Problem-solving assignments and questions	
Acquire scientific perspectives and qualifications by answering students' questions	Identify the problems and solve	
Chance to apply their acquired knowledge to new situations	Inquiry-based learning	
	Scientific thinking	
	Practice of scientific process and experimental methods	
	Assign critical thinking homework	

Most science teachers ask brief, critical questions and assign work to develop thinking, but rarely use ICT, inquiry-based learning, or group work to foster problem-solving or apply knowledge. Students mainly answer questions with minimal thought, with few opportunities to apply their knowledge. Teachers cite syllabus and workload constraints, but some create environments for applied learning, such as science fairs, and believe that short questions promote critical thinking. Higher-order questions and praise motivate students, but opportunities for extensive application are limited. An expert noted that decision-making helps develop critical thinking, with group work sharing ideas to find solutions (E1). Another said inquiry-based learning encourages critical thinking, enabling students to work on problems and find solutions (E2).

C. Collaboration and Communication

Table 4

Teachers' teaching-learning practices in science classes, practices mentioned in the secondary science curriculum and Teacher Curriculum Guide, and expert opinion

regarding collaboration and communication skills

Teachers' Practice in the Science Classes	Mention practices in the Science Curriculum & Teacher Curriculum Guide	Expert Opinion
Students can share their problems	Collaborative work	Communication
Group work		Problem solving
		Group work

All teachers had good relationships with students, who asked questions and shared issues. Teachers rarely assigned group work but responded well to students' problems, especially science teachers who explained topics clearly. Some teachers acknowledged the importance of group work but noted that students tend to gossip or game rather than discuss. To develop communication skills, some used group tasks such as poster-making and drawing competitions to promote interaction and learning. An expert said practicing communication and problem-solving fosters collaboration. (E1) emphasized communication and collaboration as vital skills, involving receiving and expressing, with collaboration helping generate solutions. Another expert highlighted student-centric teaching, where students communicate and develop skills themselves.

D. Creativity**Table 5**

Teachers' science teaching practices, secondary science curriculum and Teacher Curriculum Guide guidelines, and expert views on creativity

Teachers' Practice in the Science Classes	Mention practices in the Science Curriculum & Teacher Curriculum Guide	Expert Opinion
Short creative questions	Use of ICT	Problem solving
Structured creative questions	Creative homework	Inquiry-based learning
	Including creative questions in the lesson plan	Project-based learning
	Practice of scientific process and experimental methods	
	Learning by doing	
	Thought-provoking, critical thinking, and creative questions and class work	

Over half of teachers used structured creative questions, mostly asking short questions, with none using ICT or other creative methods. Few assigned these questions as classwork or homework. Students confirmed that teachers practiced only structured creative questions, focusing solely on them to boost creativity. One teacher said, “I try to discuss a topic clearly so students can write and answer creative questions well if they understand the topic or have read it thoroughly” (T1). Another added, “I use lecture and discussion methods in every topic to help students answer creative questions easily” (T4). Experts agree that problem-solving and inquiry-based learning enhance classroom creativity. E1 noted creativity relates to expression; some share feelings comfortably, others do not. Allowing everyone to express themselves fosters creativity, especially in identifying and analyzing gaps. Using problem-, inquiry-, and project-based methods promotes automatic creativity. E2 highlighted that in science, creativity involves generating new ideas. Students need opportunities for problem-solving, but teacher-centric classrooms limit them. Teachers should assign problems and encourage inquiry in topics of interest to foster creativity.

E. Leadership

Table 6

Teachers’ teaching-learning practices in science classes, practices mentioned in the secondary science curriculum and Teacher Curriculum Guide, and expert opinion regarding leadership

Teachers’ Practice in the Science Classes	Mentioned Practices in the Science Curriculum & Teacher Curriculum Guide	Expert Opinion
Collected notebooks of the students	Collaborative work	Collaborative practice and group work
Draw a picture on the board	Practice leadership in group work	Teachers need to follow pedagogy to practice leadership
Select a leader for the group work		

Most teachers rarely practice leadership skills with students in science classes, often not assigning captaincy or group work, and thus offering no opportunity for students to lead. Some did assign specific tasks, such as instructing students or collecting notebooks, usually during class. A few teachers used student-chosen or performance-based group leaders. Two teachers did not practice leadership due to curriculum limitations or time constraints, citing the lack of leadership topics in textbooks and pressure to finish the syllabus. An expert noted leadership’s importance for the future, developing through collaborative teaching with

teachers facilitating and leading students, encompassing democratic and distributed styles. Another expert highlighted practicing leadership through group work inside and outside the classroom, emphasizing sound pedagogy to foster leadership skills.

F. ICT literacy

Table 7

Teachers' teaching-learning practices in science classes, practices mentioned in the secondary science curriculum and Teacher Curriculum Guide, and expert opinion regarding ICT Literacy

Teachers' Practice in the Science Classes	Mention Practices in the Science Curriculum & Teacher Curriculum Guide	Expert Opinion
No use of ICT	Inquiry-based learning ICT-related modern tools and techniques for science education Develop an environment for students where they can use modern technology.	Physical technology plays a vital role in the future world. If we do not focus on ICT, science education will not be achieved well.

All classrooms lacked multimedia despite being spacious and well-equipped with lights, fans, switches, switchboards, and electricity. Teachers never used multimedia or technology for science lessons. Students said there was no permanent multimedia in classrooms, but facilities are available. All teachers said they do not use multimedia; only one teacher owns a personal projector, which he uses occasionally, and their school has one. They can get help from electricians if needed to use devices in classrooms. (T3). No teacher used multimedia in science class. Two of the nine suggested online links. All students agreed that ICT deepens learning. One expert sees ICT as vital for future connectivity and pedagogy (E1). Another argues ICT is not crucial for science, emphasizing ICT literacy over direct use and criticizing excessive screen projection (E2).

4.3 Teachers' Challenges during the Practice of 21st-Century Skills in the Science Classroom

This section analyzes junior secondary science teachers' challenges in implementing 21st-century skills. Data are presented in three steps: 1) identifying one major theme, 2) identifying five minor themes, and 3) analyzing major themes under minor themes.

A. Critical Thinking and Problem Solving

All teachers asked critical-thinking questions during class, but could not give individual attention to over fifty students. They focused on critical questions to promote critical thinking, but many students struggled to answer. One non-government school teacher explained she asks short questions after lessons and provides classwork to gauge

understanding. If 60% can answer, she considers the topic understood; if not, she reteaches it. Another teacher believes that children lack higher-order thinking skills, struggle to understand questions, and do not practice problem-solving as much as university students do. Two teachers cited student inattentiveness and impatience as barriers. One mentioned issues like students' lack of interest in reading and family problems as barriers to practicing critical thinking and problem-solving. Two shared that students asked questions, but teachers could not always answer immediately; they noted them and researched answers later.

B. Collaboration and Communication

Six of nine classrooms were overcrowded, complicating seat rearrangements for group work. Four teachers reported noise and distractions that affected student attention. One teacher noted that large class sizes hinder bench arrangements, causing further issues.

C. Creativity

All teachers used structured questions to promote creativity in science classes. When asked about challenges, most reported difficulty practicing creative questions, especially because students struggled to answer logically or understand how to respond. Some students answered based on imagination, making it hard for teachers to interpret responses. Teachers also lacked time to practice creative skills. Additionally, some parents and students preferred quick exam performance over deeper learning, further hindering the development of creative questions.

D. Leadership

Out of nine classes, six had over fifty students. Teachers randomly selected students for work, often assigning captaincy. Over half of the students reported feeling upset when they were not chosen as captain, leading to dissatisfaction. A non-government school teacher said, "If I focus on one student, others feel bad, and with exams approaching, it is hard to do everything in time." Few teachers noted issues when leaders could not fulfill duties; one class six teacher added, "Sometimes students do not follow leaders' instructions or refuse to listen." (T1).

E. ICT literacy

All teachers faced a lack of multimedia setups in their science classrooms despite their usefulness. Of the nine teachers, five saw this as a major obstacle, citing limited facilities. Three lacked permission to use mobile phones for teaching media, causing delays. Two reported electrical issues, and one could not use multimedia due to a lack of training despite recognizing its value.

Key Findings

1. Reflected 21st-Century skills

- a) Both CPD and P21 frameworks mention five key 21st-century skills: critical thinking and problem-solving, collaboration and communication, creativity,

leadership, and ICT literacy, which are reflected in the secondary science curriculum, education policy, and teacher curriculum guide.

2. Strategies Teachers used to Implement 21st-Century Skills in Science Classrooms:

Most of the teachers and students were unfamiliar with the term "21st-century skills". After the researcher gave a brief description of 21st-century skills, the participants were able to recognize them.

- **Critical Thinking and Problem Solving:** Most teachers ask short, critical-thinking questions from the science book and assign thinking-based classwork. Half of the students said teachers also give thoughtful homework. Nearly all teachers assign classwork, homework, and questions to promote critical thinking. Most of them create environments where students apply what they have learned.
- **Collaboration and Communication:** All students said teachers rarely assigned group work. They share their problems and get good responses from their respective teachers. Half of the teachers said they assign tasks like poster-making or drawing competitions to improve communication skills.
- **Creativity:** All teachers use structured creative questions to develop students' skills in science classrooms, practicing both short and structured questions.
- **Leadership:** Most teachers practiced leadership skills by assigning captaincy and selecting leaders during group work in science classes. However, two teachers did not practice leadership skills.
- **ICT literacy:** None of the classrooms had multimedia setups, and teachers did not use multimedia or devices in science classes. Only two of nine teachers recommended online educational resources to help students understand science topics.

3. Challenges Teachers Faced during the Practice of 21st-Century Skills

- **Critical Thinking and Problem Solving:** Since there were over fifty students per class, teachers could not focus on all of them during lessons. Half of the teachers said that when practicing critical-thinking questions, many students did not grasp how to answer due to impatience and inattention. Teachers also struggled when students asked critical questions.
- **Collaboration and Communication:** Most classes had too many students, making group work difficult. Half of the teachers reported noise, inattentiveness, and issues with bench arrangements during these activities.
- **Creativity:** All teachers used only book-based, structured questions in science classes, hindering the promotion of creative skills. Most students struggled to answer because they did not read the chapter well, which led to

misunderstandings. Two teachers also cited a lack of time to teach creative skills properly.

- **Leadership:** Teachers struggled to assign work due to too many students. Many are upset about not being captains, causing dissatisfaction. Sometimes, leaders could not fulfill their duties, which led to problems.
- **ICT Literacy:** All teachers faced a problem: no multimedia setup in science classrooms. Although schools had limited multimedia facilities, teachers could not use them freely. They needed permission from the authorities and had to check if others had booked the equipment before using it.

5. Discussion

The British Council's CPD Framework (2015) and the Partnership for 21st Century Skills (2009) outlined key 21st-century skills: critical thinking, problem-solving, collaboration, communication, creativity, leadership, and ICT literacy. These skills are reflected in Bangladesh's Secondary Science curriculum (2012), the national education policy (2010), and the Teacher Curriculum guide (2017). Land and Jonassen (2012) highlighted student-centered learning, encouraging questions and engagement in science. Students often follow instructions passively, and teachers rely on lectures despite curriculum guidance for interactive methods. While computers assist instruction, traditional methods persist, requiring a wider range of resources. Lesson plans help embed questions and develop thinking skills, but workload hampers adherence. Experts recommend comprehensive planning for 21st-century skills, though some accept less strict approaches. Teaching should focus on learner-centric activities to promote participation and 'how to learn,' but many teachers mainly lecture and use basic labs. Interactive practices are vital. Science education should emphasize critical thinking and inquiry over memorization. Teachers tend to ask low-level questions, focusing more on knowledge delivery than skills, which hampers deep thinking. Inquiry-based activities could enhance competencies. Collaboration develops communication and leadership, but group work is rarely assigned; some do projects like posters. Experts advocate collaboration to encourage idea exchange and innovation. Problem-solving opportunities can boost these skills. Science activities should meet international standards by fostering creativity and skills, but the focus remains on questions. Homework and inquiry-based learning, especially with ICT, are underutilized; project-based methods are recommended. Leadership develops through practice. Teachers often assign simple roles and rarely act as formal leaders. Group work and ICT use are minimal; some see ICT as vital, but traditional methods dominate, and multimedia tools are lacking. A skills teacher struggled to foster critical thinking, including students' misunderstandings and difficulty answering questions (Zainudin et al., 2019). Teachers could not always answer student questions immediately. Group work issues included noise, inattentiveness, poor seating, and resistance to change. Parental attitudes also undervalued collaboration. Studies (Ha Le et al., 2018) show low attention, disinterest in teamwork, and social barriers, especially for low-status students and disruptive peers, hindering activities. Teachers struggled with creative and leadership skills, often unable to formulate creative questions

due to students' limited reading and understanding, causing misunderstandings. Experts recommend training in creative, problem-based, and inquiry methods. Raba (2016) pointed out that traditional methods hinder leadership, but positive attitudes and innovative teaching can help. No classrooms had multimedia setups, so ICT tools were unused. While developed countries use Wi-Fi and multimedia, many Bangladeshi schools lack these due to large class sizes. Teachers need to be creative and adopt diverse technologies to engage students.

6. Conclusion & Recommendation

This study found that the education policy, junior secondary science curriculum, and teacher curriculum guide incorporate many 21st-century skills, such as critical thinking, problem-solving, and creativity, with practices outlined in the 2012 curriculum and guide. However, it placed less emphasis on skills like collaboration, communication, and leadership. The Teacher Guide detailed the use of ICT, but most teachers practiced these skills partially and unevenly in their junior secondary science classroom. They primarily asked critical-thinking questions and promoted critical thinking, but avoided problem-solving or leadership activities. They also promoted creativity by asking book-based structured creative questions. While they practiced communication and collaboration by answering questions, the limited use of multimedia tools hindered ICT literacy. Some teachers suggested online resources, but most relied on traditional methods, reducing effective skill practice. Teachers faced many challenges, and the findings suggest that curriculum development, school policies, and teacher training can help overcome these problems. Knowing which assessment systems junior secondary science teachers use to assess students' 21st-century skills, as well as the challenges students face in practicing them, is crucial. Future research should explore these areas.

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