Human-Centric Skills in Rural Secondary Science Education in Bangladesh: Teacher Practices and Institutional Constraints

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ABSTRACT

Human-centric skills such as critical thinking, creativity, and collaboration are increasingly recognized as essential competencies in contemporary education. Teachers play a crucial role in translating these competencies into classroom practice, particularly in resource-constrained rural contexts. However, limited research has examined how these skills are enacted in rural science classrooms, especially regarding the interaction between teacher practices and institutional constraints. This study investigates how science teachers in rural secondary schools in Bangladesh foster human-centric skills development and how institutional factors shape their pedagogical practices. Drawing on Self-Determination Theory and the 21st Century Skills Framework, the study employed a qualitative multiple case study design within an interpretivist paradigm. Data were collected through semi-structured interviews and classroom observations with eight purposively selected teachers across four rural schools. Thematic analysis, following Braun and Clarke's approach, was used to identify recurring patterns and contextual barriers in instructional practices. Findings indicate that teachers adopt adaptive and student-centred strategies to support students' autonomy, competence, and relatedness despite structural constraints such as limited resources and rigid curricula. The study highlights teacher agency as a critical factor in navigating institutional challenges and offers context-sensitive implications for policy and practice in rural science education.

Keywords- Human-centric skills; Science education; Rural secondary education; Self-Determination Theory; Bangladesh

INTRODUCTION

The rapid advancement of digital technologies is reshaping educational priorities by redefining the competencies required for future learners. Within this changing educational context, education systems are increasingly expected to move beyond knowledge transmission. Instead, greater emphasis is placed on human-centric skills such as critical thinking, creativity, collaboration, and problem-solving (World Economic Forum, 2020; UNESCO, 2024). This reflects broader changes in how learners are prepared for increasingly complex and dynamic environments.

Within science education, this transformation is particularly significant due to the subject's emphasis on inquiry, reasoning, and problem-solving. Evidence indicates that student engagement and deeper learning are enhanced through interactive and learner-centred pedagogies (Reeve & Cheon, 2024; Tao et al., 2025). However, classroom practices in many contexts remain dominated by examination-oriented approaches, limiting opportunities for higher-order skill development (Voogt & Roblin, 2012).

These pedagogical challenges are closely linked to institutional conditions. Teaching practices continue to be shaped by structural constraints, including limited resources, infrastructural challenges, and rigid curricula (OECD, 2023). In rural secondary schools in Bangladesh, such constraints are especially pronounced, contributing to disparities in instructional quality and learning opportunities. Although policy agendas increasingly promote competency-based education aligned with contemporary skill demands, implementation

remains uneven.

Statement of Problem

Despite growing global and policy emphasis on human-centric skills, how these competencies are enacted in classrooms remains under-explored in context-specific ways. Existing theoretical frameworks, including Self-Determination Theory and 21st-century skills models, advocate for autonomy-supportive and participatory pedagogies. However, the implementation of these approaches often remains weakly grounded in human-centric and context-sensitive practices (Topali et al., 2025; Hu & Chan, 2025).

At the same time, empirical studies frequently examine teacher practices or institutional constraints in isolation, providing limited insight into how these factors interact in shaping classroom processes. This limitation is particularly critical in rural and resource-constrained settings, where contextual factors play a decisive role in mediating pedagogical possibilities. The implementation of interactive pedagogical practices remains highly dependent on local institutional conditions (González-Rico & Lluch Sintes, 2024).

Accordingly, a key gap remains in understanding how teachers interpret, negotiate, and enact human-centric skills within structurally constrained environments. Addressing this gap is essential for developing contextually grounded and theoretically informed accounts of science teaching and learning in contemporary education systems. This study addresses the following research questions:

1. How do science teachers conceptualize and enact human-centric skills within rural secondary classrooms?

2. How do institutional and structural conditions enable or constrain the enactment of these skills?

3. How do teachers navigate and mediate these constraints in practice?

4. How do these dynamics shape the realization of human-centric skills development in science education?

LITERATURE REVIEW

Human-Centric Skills in Contemporary Education

Human-centric skills refer to a broad set of cognitive, social, emotional, and ethical competencies that enable individuals to function effectively in contemporary societies. These include critical thinking, creativity, collaboration, communication, empathy, adaptability, and ethical reasoning. In contemporary educational discourse, these skills are increasingly positioned as essential learning outcomes in response to global societal change and evolving workplace demands (World Economic Forum, 2020; OECD, 2023).

Unlike traditional academic achievement, human-centric skills emphasize agency, interaction, and relational capability. They require pedagogical environments that foster active engagement, autonomy, and meaningful participation. International frameworks such as the OECD Learning Compass 2030 and the Partnership for 21st Century Learning emphasize a shift from knowledge transmission toward competency-based learning models (OECD, 2019; Partnership for 21st Century Learning, 2019).

Self-Determination Theory (SDT)

Self-Determination Theory (SDT), developed by Deci and Ryan, provides a foundational framework for understanding human motivation and psychological development. SDT proposes that optimal functioning occurs when three basic psychological needs are satisfied: autonomy, competence, and relatedness (Ryan & Deci, 2017).

Autonomy-supportive teaching practices, such as offering choice, encouraging reflection, and promoting dialogue enhance intrinsic motivation and engagement. Empirical research shows that SDT-based pedagogical approaches improve students' self-regulation, engagement, and socio-emotional outcomes across contexts (Aelterman et al., 2019; Patall et al., 2024). In science education, SDT is widely used to explain how teacher behaviors influence deeper learning, including conceptual understanding and collaborative engagement.

The 21st Century Skills Framework

The 21st Century Skills Framework identifies competencies required for learners in contemporary societies. These are grouped into learning and innovation skills, information and communication literacy, and life and career skills (Partnership for 21st Century Learning, 2019).

Learning and innovation skills include critical thinking, creativity, communication, and collaboration. Life and career skills emphasize adaptability, leadership, initiative, and social responsibility. The OECD Learning Compass 2030 further extends this framework by emphasizing student agency, co-agency, and transformative competencies, such as creating new value and reconciling tensions (OECD, 2019).

Together, these frameworks reflect a shift from rote learning toward learner-centred, competency-based education systems.

Integration of SDT and 21st Century Skills

The integration of Self-Determination Theory and the 21st Century Skills Framework provides a comprehensive lens for understanding human-centric learning. SDT explains motivational processes why students engage, while the 21st Century Skills Framework defines expected competencies.

When combined, these skills emerge most effectively in environments that support autonomy, competence, and relatedness while fostering collaboration and inquiry. Teachers act as key mediators between motivational conditions and competency development. Recent studies confirm that SDT-based instructional approaches also enhance 21st-century competencies such as collaboration and critical thinking (Aelterman et al., 2019; Schmid et al., 2024).

Teacher Practices and Institutional Constraints

Teacher practices play a central role in human-centric skills development. Constructivist approaches such as inquiry-based learning, project-based learning, and collaborative activities are strongly associated with improved critical thinking, creativity, and communication skills (Voogt & Roblin, 2012).

From an SDT perspective, autonomy-supportive teaching enhances intrinsic motivation and engagement in higher-order learning. However, implementation is often constrained by curriculum rigidity, high-stakes examinations, and limited resources. In low-resource rural contexts, these constraints lead to teacher-centred instruction focused on exam preparation, limiting pedagogical innovation (OECD, 2023).

Synthesis and Research Gap

Although SDT and the 21st Century Skills Framework are widely studied, limited research integrates them to explain human-centric skills development in rural, resource-constrained contexts. Most studies focus on urban or well-resourced settings, leaving a gap in understanding how institutional constraints shape teacher practices in rural schools. Furthermore, there is insufficient qualitative evidence on how teachers operationalize SDT constructs of autonomy, competence, and relatedness under structural limitations.

The interaction between teacher agency and institutional constraints remains under-explored in relation to human-centric skills development. Addressing this gap is essential for developing a context-sensitive understanding of how human-centric skills are fostered in rural secondary education systems, particularly in science education contexts such as Bangladesh.

METHODOLOGY

This study adopted a qualitative multiple case study design within an interpretivist paradigm, informed by Self-Determination Theory (SDT) and the 21st Century Skills Framework, to explore how teachers enact human-centric skills in classroom contexts. The study was conducted in four rural secondary schools in Bangladesh, selected to represent resource-constrained educational settings. These schools operate under similar curricular structures and examination-oriented assessment systems, providing a relevant context for examining institutional

constraints on pedagogical practices.

A purposive sampling strategy was used to select eight science teachers based on teaching experience, subject specialization, and willingness to participate. The sample ensured variation in classroom context while maintaining relevance to rural science education. A sample size of eight is appropriate for qualitative multiple-case study designs, where depth and contextual understanding are prioritized over statistical generalization.

To enhance transparency and contextual understanding, school-level characteristics such as class size, student-teacher ratio, and availability of teaching and laboratory resources were documented (see Table 1).

Table 1: Participant and School Characteristics

Teacher	Experience (years)	School	Class Size	Student-Teacher Ratio	Resources Available
T1	10	School A	45–55	45:1	Limited lab, chalkboard only
T2	8	School A	50–60	50:1	No functional lab
T3	12	School B	40–50	42:1	Basic materials only
T4	7	School B	55–65	55:1	No lab equipment
T5	9	School C	60+	60:1	Minimal resources
T6	11	School C	50–60	52:1	Chalkboard-based
T7	6	School D	40–45	40:1	Limited science kits
T8	10	School D	45–55	48:1	No laboratory access

While official examination pass rate data were not systematically available due to institutional access limitations, contextual information regarding student performance trends was obtained through teacher accounts and used to support interpretation.

Data were collected through semi-structured interviews and classroom observations. Interviews focused on teachers' understanding of human-centric skills, instructional strategies, and challenges in implementing student-centred pedagogies. Classroom observations captured actual teaching practices, particularly the extent to which autonomy, collaboration, and inquiry-based learning were enacted. No video recordings were used during classroom observations due to ethical and contextual considerations.

Instead, structured field notes were taken during and immediately after classroom sessions to ensure accurate and systematic documentation of classroom interactions. It is acknowledged that the presence of the researcher during classroom observations may have influenced teacher and student behaviour (observer effect). To minimize this influence, multiple classroom visits were conducted to allow participants to become familiar with the researcher, thereby reducing reactivity over time.

Interviews were audio-recorded and transcribed verbatim, while observation notes were documented during and immediately after classroom sessions to ensure accuracy and detail. Data were analyzed using thematic analysis following Braun and Clarke's (2006) framework, including familiarization, coding, theme development, and reporting. This enabled identification of patterns related to teacher practices, institutional constraints, and human-centric skills development.

To enhance trustworthiness, data triangulation was achieved by comparing interview and observation data. Member checking was also conducted with selected participants to ensure credibility. The study adhered to ethical standards, including informed consent, voluntary participation, and confidentiality.

FINDINGS

The analysis identified four interrelated themes, framed through Self-Determination Theory (SDT): (1) autonomy frustration due to examination pressure, (2) competence limitation due to resource constraints, (3) partial autonomy and competence support through teacher agency, and (4) relatedness development through supportive classroom relationships. Classroom observations and interview data are integrated within each theme, and findings are interpreted in relation to human-centric (21st-century) skills as secondary outcomes.

Theme 1: Autonomy frustration due to examination pressure (SDT: Autonomy)

A dominant theme across the data was the strong influence of examination-oriented schooling, which significantly restricted teacher and student autonomy.

Interview Evidence

Teacher T3 explained:

"I want to do group work, but I must complete the syllabus. Otherwise students will not pass the exam."

Teacher T1 stated:

"Everything depends on exams. Even good activities feel like wasting time." Teacher T6 added:

"Students are also not interested unless it is related to exam questions."

Classroom Observation

In a Grade 9 science lesson on "Photosynthesis," Teacher T2 initiated a discussion by asking students how plants produce food. Although students attempted to provide explanations based on prior knowledge, the teacher quickly redirected them to textbook definitions, stating that the content was "important for exams."

The interaction shifted from discussion to note-taking, limiting student participation. This restricts opportunities for inquiry, critical engagement, and creative thinking in classroom learning

This theme directly indicates autonomy frustration in SDT, as exam pressure limits teacher choice and student participation, undermining autonomy-supportive learning and restricting critical thinking and creativity.

Theme 2: Competence limitation due to resource constraints (SDT: Competence)

Teachers consistently highlighted inadequate resources and infrastructure as major barriers to effective science teaching.

Interview evidence

Teacher T5 noted:

"We do not have laboratory equipment, so science becomes only theory." Teacher T2 stated:

"Without materials, students cannot really understand experiments." Teacher T4 explained:

"Large classes make it difficult to check whether every student understands."

Classroom Observation

During a Grade 8 lesson on "Electric Circuits," the teacher explained circuit connections using only chalkboard diagrams. When students asked how real components functioned, the teacher responded that practical demonstration was not possible due to lack of equipment and instructed students to memorize the diagram for examination purposes. These conditions limit students' ability to develop practical reasoning and problem-

solving competencies through experiential learning.

This theme reflects competence limitation in SDT, where lack of resources, labs, and large classes restrict hands-on learning and reduce students' scientific reasoning and problem-solving skills.

Theme 3: Partial autonomy and competence support through teacher agency (SDT: Autonomy & Competence support)

Despite institutional constraints, some teachers demonstrated adaptive pedagogical strategies to support student engagement.

Interview Evidence

Teacher T7 stated:

"I allow students to explain in their own words even if it takes time." Teacher T3 explained:

"I try to connect lessons with real-life examples so students can understand better." Teacher T1 added:

"I ask questions to make students think, even without resources."

Classroom Observation

In a Grade 10 lesson on "Acids and Bases," Teacher T7 encouraged students to identify acidic and basic substances from their daily environment. Students actively discussed examples such as lemon, soap, and vinegar. Some students debated classifications, and the teacher facilitated discussion rather than immediately correcting answers.

Such practices contribute to the development of communication, collaboration, and analytical thinking skills among students despite structural constraints.

This theme suggests partial autonomy and competence support in SDT, as teachers provide limited student choice and contextual learning despite constraints, partially fostering collaboration and analytical thinking, though inconsistently.

Theme 4: Relatedness development through supportive classroom relationships (SDT: Relatedness)

Strong teacher-student relationships were found to play a key role in encouraging participation and reducing learning anxiety.

Interview Evidence

Teacher T6 stated:

"If students feel comfortable, they participate more even if they are weak." Teacher T4 explained:

"I try to build personal relationships so students are not afraid of science

Teacher T2 added:

"Encouragement is more important than punishment."

Classroom Observation

During a Grade 9 lesson, a student provided an incorrect answer. Instead of correcting immediately, the teacher responded, "Good try, let's think together," and guided the class toward the correct concept. The student later participated again confidently, showing increased engagement. These relational practices enhance student engagement, participation, and socio-emotional learning, supporting collaborative learning environments.

This theme illustrates strong relatedness support in SDT, where positive teacher-student relationships enhance

emotional safety and participation, indirectly supporting collaboration and communication skills.

DISCUSSION

This study explored human-centric skills development in rural secondary science classrooms using Self-Determination Theory (SDT) and the 21st Century Skills Framework. Findings show that both motivational conditions and institutional constraints jointly shape classroom practices.

Viewed through SDT, the basic psychological needs of autonomy, competence, and relatedness are only partially supported (Ryan & Deci, 2017). Autonomy is strongly constrained by examination pressure, which reduces teacher flexibility and limits autonomy-supportive instructional practices (Aelterman et al., 2019). Competence development is also undermined by resource shortages, large class sizes, and limited opportunities for practical inquiry, which restrict students' ability to develop mastery through active engagement. Relatedness is relatively more visible but still limited, as teacher-student interactions are generally supportive but remain embedded within teacher-centred instructional structures.

Through the lens of the 21st Century Skills Framework, critical thinking, creativity, and collaboration are not systematically developed, but appear inconsistently in practice (OECD, 2019; Partnership for 21st Century Learning, 2019). Instead, teaching remains predominantly focused on examination preparation, aligning with findings from previous research on exam-driven systems (Voogt & Roblin, 2012).

Despite these constraints, teachers demonstrate partial agency by incorporating questioning techniques, peer discussion, and contextual examples to support engagement. From an SDT perspective, these practices reflect partial autonomy and competence support, although they are constrained by institutional pressures and structural limitations. This indicates that autonomy-supportive teaching is present but not systematically sustained (Patall et al., 2024).

Overall, curriculum rigidity and assessment pressure strongly constrain the development of human-centric skills, leading to inconsistent implementation in rural classrooms (OECD, 2023). The findings suggest that while SDT needs are partially addressed in practice, systemic constraints significantly limit the full realization of autonomy, competence, and relatedness in science education contexts.

CONCLUSION

This study shows that the development of human-centric skills in rural secondary science classrooms is shaped by the interaction of teacher practices and institutional constraints, interpreted through Self-Determination Theory (SDT) and the 21st Century Skills Framework. Findings indicate that examination pressure, limited resources, and structural barriers restrict autonomy-supportive and student-centred teaching, leading to uneven development of skills such as critical thinking, collaboration, and creativity.

Despite these challenges, teachers demonstrate limited agency through informal but pedagogically meaningful strategies such as questioning, peer discussion, and contextual examples, although these remain individually driven rather than systemically supported. In the context of Bangladesh, more effective support could include integrating formative assessment into national examinations, introducing low-cost, school-based professional development for teachers, and allowing greater curriculum flexibility using local resources to support practical science learning.

Overall, human-centric skills development remains inconsistent in rural classrooms, highlighting the need to better align policy intentions with classroom realities in resource-constrained settings. This study contributes to the literature by extending SDT and 21st-century skills frameworks to rural Global South contexts, showing how motivational conditions and institutional constraints jointly shape human-centric skills development in science education. However, findings should be interpreted with caution due to limited scope, single-region focus, and observational constraints.

Data Availability Statement

The data generated and analysed during this study are not publicly available due to ethical restrictions and

participant confidentiality. Requests for anonymized data may be considered by the corresponding author upon reasonable request.

Ethical Approval

Ethical approval for this study was obtained from the relevant institutional ethics committee prior to data collection.

Conflict of Interest

The authors declare no conflict of interest.

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