Supplementary Material: Comprehensive Qualitative Analysis with Detailed Transcripts

Overview

This supplementary material provides comprehensive qualitative findings from 15 individual teacher interviews (45-60 minutes each) and 3 focus group discussions (90 minutes each) conducted February-March 2024. All participants provided informed consent for participation and quotation.

A.1 Teacher Training and Professional Development

Core Finding

Effective training programs combine theoretical knowledge with practical application, building teacher confidence to implement CCE through local relevance and hands-on approaches.

Detailed Evidence

T-15 (Rural teacher, 12 years experience, Grade 8 science): "After attending a workshop on climate change, everything changed for me. Before, I would just read about weather patterns from the textbook. Now I can connect what students see in their daily lives - the changing rainfall, their family's crop struggles - with the science behind climate change. The workshop gave me practical examples I could use immediately. My students are much more engaged now because they see it's not just abstract science, it's their reality. Before the training, I would avoid climate topics because I wasn't sure how to explain them properly. The workshop didn't just give me content knowledge - it gave me confidence."

T-08 (Urban teacher, 7 years experience, Grade 6): "Training helped me understand not just what to teach, but how to make it relevant to our local conditions. The workshop changed my perspective completely. They showed us how to use simple experiments to demonstrate greenhouse effects, how to connect local weather changes to global patterns. Most importantly, they gave us ready-to-use lesson plans we could adapt to our context. I learned that you don't need expensive equipment - you can use plastic bottles and thermometers to show how greenhouse gases work."

T-14 (Rural teacher, 10 years experience, multi-grade classroom): "At first, I was uncertain about teaching climate change but seeing how students respond to local environmental examples has made me more confident and enthusiastic. What made the difference was learning from other teachers who had successfully implemented climate education. Seeing their classroom examples made me realize it was possible even with our limited resources. The peer learning aspect was crucial - hearing how other rural teachers overcame similar challenges."

Administrator A-02 (Urban school principal): "We've noticed a clear difference in teachers who attended specialized climate training versus those who haven't. The trained teachers are more creative, more confident, and their students seem more engaged with environmental topics. They're also more likely to integrate climate themes across different subjects, not just science class."

A.2 Institutional Support and Administrative support

Core Finding

Administrative support creates enabling environments through resource provision, time allocation, policy backing, and institutional validation of CCE efforts.

Detailed Evidence

T-12 (Urban teacher, 8 years experience, Grade 6): "Having the knowledge and the school's support makes a huge difference. When our principal actively encourages climate education and provides resources, it reinforces our commitment to teaching these topics. Our principle makes all the difference. She doesn't just say climate education is important - she gives us time to plan together, found materials funding, and even arranged for a local farmer to speak to classes about changing weather patterns. When administration supports you, you feel empowered to try new things. Compare that to my previous school where the principal only cared about test scores - there, I felt discouraged from spending time on anything not directly tested."

T-07 (Rural teacher, 15 years experience, multi-subject): "My principal is more focused on test scores than environmental education. Without their backing, it is hard to prioritize climate topics. When I tried to spend time on climate topics, I was told to focus on what's tested in national exams. It's frustrating because students are naturally interested in environmental issues they see at home, but I feel pressure to stick to textbook content. Administrative attitude really shapes what we feel comfortable teaching."

T-16 (Urban teacher, 6 years experience, Grade 7): "Administration support isn't just about resources - it's about validation. When your principal attends your climate education activities and praises your efforts publicly, it motivates you to do more. Recognition matters a lot in teaching. If your efforts are acknowledged and celebrated, you're more likely to invest time and energy in developing innovative approaches."

Administrator A-02 (Urban school principal): "We want to prioritize environmental education, but our teachers can only do so much without adequate resources. We realized that just telling teachers to include climate education wasn't enough. We had to provide time, materials, and recognition. Now we have dedicated planning sessions, and we showcase successful climate education activities in our monthly meetings. We also created a small budget line for environmental education materials."

A.3 Resource Availability and Creative Innovation

Core Finding

Resource constraints drive pedagogically effective innovation but create unsustainable workload burdens that threaten long-term implementation without systematic support.

Detailed Evidence

T-03 (Rural teacher, 15 years experience, multi-grade classroom): "We make do with what we have—using local newspapers, collecting environmental samples, and creating our worksheets. It is time-consuming but necessary because we have no budget for proper materials. Sometimes I wonder how long I can keep this up. I spend my own money on materials and my weekends preparing resources. The irony is that some of our locally-created materials work better than expensive textbooks because they're directly relevant to students' lives. But it's exhausting to constantly create everything from scratch."

T-11 (Urban teacher, 9 years experience, Grade 7): "When we have proper teaching materials, students are more engaged and I can demonstrate concepts effectively. But when we don't, I spend my weekends creating materials from scratch. It works, but it's exhausting. There's a limit to how much extra work teachers can take on. Good materials make a difference - students can see climate concepts in action rather than just hearing about them."

T-16 (Rural teacher, 6 years experience, small village school): "We have to rely on printed handouts or create our materials because no official resources are available. We don't have internet, printed materials, or science equipment most days. But our students live climate change daily - they see their parents struggling with unpredictable weather. I use their direct experience as our 'textbook.' In some ways, we have richer source material than city schools - real environmental changes happening in our community."

T-13 (Urban teacher, 4 years experience, moved from rural to urban): "The difference in resources between urban and rural schools is shocking. When I taught in the village, we had nothing. Here in the city, we have computers, internet, printed materials. It's like teaching in different countries. But I learned valuable lessons about creativity and using local resources during my rural years that I still apply in the city."

A.4 Urban-Rural Disparities and Compound Disadvantages

Core Finding

Geographic inequalities create simultaneous disadvantages requiring comprehensive interventions, but rural contexts offer unique, authentic learning opportunities.

Detailed Evidence

T-05 (Rural teacher, 6 years experience, small village school): "When I visited the school in Khon Kaen city for a workshop, I was amazed. They had computers, internet, printed materials about climate change, even a weather station. Here in our village school, we don't even have reliable electricity. But you know what? My students understand climate change more directly - they live it every day. The challenge is connecting their experience with the science when I don't have the tools to explain the bigger picture. We need support to bridge that gap between lived experience and scientific understanding."

T-09 (Urban teacher, 5 years experience, former rural teacher): "I started my career in a rural school before moving to the city. Rural teachers' challenges are immense - no resources, training opportunities, or administrative support. Yet they're often more creative and dedicated than us urban teachers. They have to be innovative just to survive. But there's only so much individual creativity can accomplish without systematic support."

Administrator A-01 (Rural district administrator): "Our rural schools are fighting an uphill battle. Limited budgets, difficulty attracting qualified teachers, poor infrastructure. Climate education becomes secondary when you're struggling with basic educational needs. We need targeted support recognizing rural schools aren't just under-resourced urban schools - they have different needs and advantages that should be leveraged."

T-04 (Rural teacher, 18 years experience, community leader): "Despite all our challenges, rural students understand climate change more directly than city students. They live it every day. Our job is to help them connect their lived experience with scientific understanding, but we need support to do this effectively. Learning becomes much more meaningful when students can relate science to their family's farming experiences."

A.5 Knowledge-Implementation Gap

Core Finding

Individual content knowledge is necessary but insufficient for effective implementation, requiring systematic support structures that enable teachers to translate expertise into engaging practice.

Detailed Evidence

T-09 (Urban teacher, 5 years experience, master's degree in environmental science): "I understand the importance of teaching about climate change, and I want to do more, but without proper teaching materials, it is challenging to translate this knowledge into effective lessons. I have a master's degree in environmental science and understand climate science very well. I know what students should learn about greenhouse gases, carbon cycles, and adaptation strategies. But knowing the content and being able to teach it effectively are completely different things. Without my school's support and proper materials, my knowledge stays theoretical. Students need to see it, experience it, not just hear me lecture about it."

T-06 (Rural teacher, 11 years experience, large class sizes): "With 45 students in my class, it's difficult to do hands-on climate activities that would be more effective. I know about climate change from my reading and research. But how do you explain complex scientific concepts to Grade 5 students using only chalk and blackboard? Knowledge isn't enough - you need tools and training to make complex concepts accessible to young learners. Class management becomes even more challenging when trying innovative teaching methods."

T-10 (Urban teacher, 13 years experience, secondary science): "Understanding climate science is just the first step. The real challenge is making it relevant and engaging for students, especially when they think it's happening far away, not in their communities. You need pedagogical content knowledge - knowing how to teach climate science, not just knowing climate science. This requires specialized training that most of us haven't received."

A.6 Student Engagement Through Local Relevance

Core Finding

Students respond most positively when climate education connects to their immediate environment and lived experiences, transforming abstract concepts into meaningful learning.

Detailed Evidence

T-15 (Rural teacher, 12 years experience): "When I started connecting climate science to what students see at home - their family's changing farming practices, the unusual weather patterns - everything clicked. They stopped seeing it as abstract science and started seeing it as their reality. Students would come to class excited to share observations from home. Parents started asking me questions about climate change because their children were bringing knowledge home."

T-11 (Urban teacher, 9 years experience): "The most successful lesson I taught was when we analyzed our local weather data and compared it to what their grandparents remember. Students were fascinated to discover their city was getting hotter and rainfall was becoming

more unpredictable. Then they went home and had conversations with their families. My parents started asking me about climate change. It's incredibly powerful when the whole community becomes part of the learning process."

T-08 (Urban teacher, 7 years experience): "Students are naturally curious about environmental changes they observe. Learning becomes much more effective when we can channel that curiosity into scientific understanding. The key is helping them see that science isn't something that happens in laboratories far away - it's explaining what they see in their daily lives."

A.7 Community and Family Connections

Core Finding

Community engagement transforms CCE from academic exercise to lived family knowledge, creating reinforcement loops that extend learning beyond classroom settings.

Detailed Evidence

T-12 (Urban teacher, 8 years experience): "We arranged for a local farmer to speak to classes about changing weather patterns. Students were amazed to hear scientific explanations for what they'd observed at home. It created great discussions between students and their families. The farmer could explain adaptation strategies in practical terms connected with scientific concepts we'd been learning. Community expertise enriched our classroom learning."

T-04 (Rural teacher, 18 years experience): "Our best climate education happens when we connect with the community. Students interview their grandparents about weather changes, visit local farms to see adaptation strategies. The whole community becomes part of the learning process. Traditional and scientific knowledge complement each other beautifully when we create space for both."

Administrator A-04 (Urban school administrator): "We've found that when students take climate learning home, it creates conversations that extend education beyond school walls. Parents become more supportive of climate education when they see their children bringing valuable knowledge home. Some parents have even changed household practices based on what their children learned at school."