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Contextual Teaching and Learning of Science in Elementary Schools

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Contextual Teaching and Learning (CTL) integrates inquiry, problem- and project-based learning, cooperative learning, and authentic assessment. Case studies were carried out on 21 teachers who used CTL to teach science in elementary schools to diverse groups of children. The findings indicated that the conditions that fostered the implementation of CTL strategies were a collaborative interaction with students, a high level of activity in the lesson, a connection to real-world contexts, and an integration of science content with other content and skill areas. Furthermore, the CTL strategies were best implemented when teachers used them in conjunction with sound classroom management techniques.

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One of the major goals of recent reform efforts in science education has been to ensure that various instructional approaches shared with teachers during inservice teacher enhancement are relevant to the challenges that actually confront them in their daily teaching practice (Meijer, Zanting, & Verloop, 2002). Our purpose in this article is to report findings on an innovative approach that is having a significant impact on the teaching of science in elementary schools.

For ten years now, the National Science Education Standards (National Research Council, 1996) have provided a vision for science education reform. The standards have helped teachers plan lessons, teach effectively, assess validly, and refine their knowledge and skills continually. Since 1998, the University of Georgia (UGA) has participated in a federally supported project to design a model program for the continued professional development of elementary school teachers. In its present form, the program reflects the significant influences of the standards, the *Pathways to the Science Education Standards—Elementary School Education Edition* (Lowery, 1997), and an innovative instructional approach called Contextual Teaching and Learning (Johnson, 2002; Sears, 2002; Sears & Hersh, 2000).

Contextual Teaching and Learning (CTL) is based on situated cognition research (Cobb & Bowers, 1999; Kumar & Voldrich, 1994) which has found that constructivist processes such as critical thinking, inquiry learning, and problem solving should be situated in relevant physical, intellectual, and social contexts (Brown, 2000; Cavallo, Miller, & Saunders, 2002; Downing & Gifford, 1996; Driver, Asoko, Leach, Mortimer, & Scott, 1994; Glynn & Duit, 1995). CTL is consistent with a constructivist approach for the teaching of science in elementary schools

(Bentley, Ebert, & Ebert, 2000). The CTL approach anchors teaching and learning in students' diverse life contexts and prepares students for learning in the complex environments they will encounter in their future careers.

CTL is a grassroots initiative that has emerged from teachers' efforts to build upon situated-cognition research and integrate into one approach a number of validated strategies that are too often employed independently of one another. As implemented in the UGA program for teaching science in elementary schools, these CTL strategies include (1) inquiry learning, (2) problem-based learning, (3) cooperative learning, (4) project-based learning, and (5) authentic assessment. These strategies are described in detail in Table 1. In order for these component CTL strategies to be used effectively, they should be used with other commonly accepted good teaching practices such as promoting self-regulated learning and addressing student diversity when teaching (Chiappetta & Koballa, 2002; Loucks-Horsley, Lovle, Stiles, Mundry, & Hewson, 2003).

CTL is a constructivist approach to learning in that it focuses on knowledge that is highly contextualized and relevant to students (Driver et al., 1994; Johnson, 2002; Morrell, 2003). CTL emphasizes using concepts and process skills in real-world contexts that are relevant to students from diverse backgrounds. This approach "motivates students to make connections between knowledge and its applications to their lives as family members, citizens, and workers and to engage in the hard work that learning requires" (Sears & Hersh, 2000, p. 4).

CTL is not a cookbook approach to teaching science. Instead, its component strategies provide a set of integrated tools that elementary school teachers can use to instruct effectively and to address controversial yet fundamentally important issues that may be raised in their classrooms—issues such as the origin of the earth, the evolution of life, and animal rights, to name only a few (Tippins, Koballa, & Payne, 2002).

The purpose of the present study was to gain insight into the conditions that facilitate and hinder the implementation of CTL when teaching science to children from diverse backgrounds. Accordingly, case studies were conducted of 21 elementary school teachers in their classrooms, following up their two-week, full-time participation in a summer CTL graduate-level workshop.

Table 1
Contextual Teaching and Learning (CTL) Strategies

CTL (Johnson, 2002; Sears, 2002; Sears & Hersh, 2000), like any approach to instruction, is characterized by the use of some learning strategies more than others. As implemented in the present program for elementary science education, the following research-validated strategies are used in an integrated fashion:

1. *Inquiry learning*. Students learn science in much the same way that science itself is carried out. Inquiry refers to those processes and skills used by scientists when they investigate natural phenomena. Inquiry involves an understanding of "how and why scientific knowledge changes in response to new evidence, logical analysis, and modified explanations debated within a community of scientists" (NRC, 2000, p. 21).

2. *Problem-based learning*. Students are given either a real or simulated problem and must use critical thinking skills to solve it (Gallagher, Stepien, Sher, & Workman, 1995). Ideally, they will need to draw information from a variety of disciplines. Problems that have some personal relevance to the students are often good choices because they encourage strong participation, learning, and perseverance.

3. *Cooperative learning*. Students work together in small groups and focus on achieving a common goal through collaboration and with mutual respect (Tippins et al., 2002). Each student within the group is viewed as making a significant contribution to the goal.

4. *Project-based learning*. Students work independently or collaboratively on projects of personal interest (Blumenfeld, Krajcik, Marx, & Soloway, 1994). There is an emphasis on constructing realistic and valuable work products. When these projects benefit others, and have wider social relevance, they are often described as service learning (Billig, 2000).

5. *Authentic assessment*. Students are evaluated by means of their performance on tasks that are representative of activities actually done in relevant, real-life settings, often associated with future careers. An example of an authentic assessment is a portfolio, which is "a purposeful and representative collection of student work that conveys a story of progress, achievement and/or effort" (Atkin, Black, & Coffey, 2001, p. 31).

Method

We are two university researchers who are studying elementary school teachers in connection with a CTL implementation project supported by the U.S. Department of Education. We each have been facilitating teacher professional development for more than 20 years. We recognize that society is constantly changing and, consequently, so is the nature of teaching and learning. Accordingly, we welcomed the vision for reform that the standards offered us and adopted the CTL strategies as a relevant means of implementing the standards when teaching science in elementary schools.

The 21 inservice elementary school teachers included 20 women and one male. Four of the women were African American, and one was Hispanic/Latino; the other teachers were Anglo American. They ranged in age from 22 to 48 years old (M = 32.1 years; SD = 6.7) and in teaching experience from one year to 27 years (M = 8.3; SD = 5.2). All of the teachers had bachelor's degrees; in addition, four had master's degrees and one had a doctorate. All of the participating teachers earned the professional development credits necessary to retain state teacher certification. They also received a stipend of $300 and curriculum materials.

The five CTL strategies the teachers learned have been validated by previous research (see Table 1). Most of the teachers were already familiar with the strategies, and many reported they used them regularly but independently. During the two-week summer CTL graduate-level workshop, we demonstrated a series of elementary (K-5) life science and physical science mini-lessons (e.g., bird study, earth's crust, blood circulation, soil erosion, and water pollution) selected from a curriculum-resource Internet website (Columbia Education Center, 2004) and a curriculum guide (*Project WET*, 1995). We incorporated CTL strategies into the mini-lessons following the recommendations of Sears (2002). Following the demonstration phase of the workshop, the participating teachers each carried out three one-hour simulated practice mini-lessons and received formative feedback on how to improve their use and integration of CTL strategies.

Sustained contact was maintained with the teachers over the following school year to observe their implementation of CTL strategies and to determine what facilitated and hindered implementation in actual classroom conditions. The sources of data collected on the inservice teachers included initial semistructured interviews followed by structured ones (Merriam, 2001), observations of science lessons, teacher work products (e.g., lesson plans, unit plans, and activity sheets), and student work products (e.g., activity sheets, completed tests, models, drawings, and posters).

Like all case studies, a limitation of the present ones is that they do not produce generalizable findings as do studies with experimental designs (Silverman, 2000, 2001; Stake, 1988); their value instead is to "examine the circumstances of the case to determine the ways in which the case fits the circumstances of the reader's own situation" (Erickson, 1986, p. 153). Case study methods were used here to provide information on the circumstances that facilitate and hinder the implementation of CTL strategies.

Findings

All 21 teachers used the CTL integrated strategies in their classrooms, with most using the strategies well and often, as operationalized by an analytic scoring rubric (Doran, Chan, & Tamir, 1998). The rubric, based on the CTL integrated strategies and the more-emphasis conditions of the National Science Education Standards (NRC, 1996, p. 52), is presented in Table 2. In the following sections, for economy of presentation, we describe in detail the lessons of three of the teachers—Ms. Anderson, Ms. Morton, and Ms. Roberts—who were representative of the majority. The names of the teachers and their schools are pseudonyms.

Table 2
Analytic Rubric for Evaluating Lessons

Contextual Teaching and Learning Strategies plus the National Science Education Standards (NRC, 1996, p. 52) Emphases	Key: 4 = very good, 3 = good, 2 = satisfactory, and 1 = unsatisfactory
CTL integrated strategies: Inquiry Problem- and project-based learning Cooperative learning Authentic assessment	1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
"Understanding and responding to individual student's interests, strengths, experiences, and needs"	1 2 3 4
"Selecting and adapting curriculum"	1 2 3 4
"Focusing on student understanding and use of scientific knowledge, ideas, and inquiry processes"	1 2 3 4
"Guiding students in active and extended scientific inquiry"	1 2 3 4
"Proving opportunities for scientific discussion and debate among students"	1 2 3 4
"Continuously assessing student understanding"	1 2 3 4
"Sharing responsibility for learning with students"	1 2 3 4
"Supporting a classroom community with cooperation, shared responsibility, and respect"	1 2 3 4

Case 1: Ms. Margaret Anderson, Wilson Elementary School, 1st Grade

Although Wilson Elementary School is in an urban setting, it has an unusually large campus with open spaces for sporting events, nature trails, and a butterfly garden. There are 461 students who attend Wilson in grades Pre-K through 5th grade, and there are approximately equal numbers of boys and girls. Wilson Elementary is quite diverse in terms of its student body: 22% of the students are Anglo American, 21% are Hispanic/Latino American, 54% are African American, and 2% are Asian American. About 7% have limited English proficiency. Wilson has a relatively large number of students coming from low-income families, with about 72% qualifying for a free or reduced price lunch under federal guidelines. About 11% of the children qualify for special education services.

Ms. Margaret Anderson is an African-American woman, about 40 years of age, who has been teaching children for 15 years, two of those at Wilson Elementary School. She has an undergraduate degree in music and a master's degree in early childhood education. Ms. Anderson's classroom is colorful, spacious, and well-organized, with large blooming plants everywhere. Hanging from the ceiling are three large kites in the form of butterflies. There also is a large aquarium, computers, and an abundance of art supplies.

There are 22 students in Ms. Anderson's class: 17 are African American and five are Hispanic/Latino American. The children are enthusiastic, attentive, and active; they also redirect well and raise their hands to speak.

Ms. Anderson begins her lesson on plants by reading the storybook *The Carrot Seed* by Ruth Krauss. Next, she uses the K-W-L group instruction technique to promote inquiry (Ogle, 1986), having students systematically respond to categories of questions. By means of the K-W-L technique, the students share what they know (K), what they want (W) to know, and at the end of the lesson, they express what they have learned (L). Students then move to their tables, which are set up for collaborative groups. Students work together and help one another on problems and projects assigned by Ms. Anderson, who has appointed table leaders to organize supplies for each group. Once seated at their tables, students use resource photographs to answer questions such as "What is the biggest flower in the world?" and "What plant has leaves that look like the ears of an elephant?" After students find the corresponding photographs, Ms. Anderson asks questions such as "Where do you think the plant in the photo grows?"

Ms. Anderson has brought in a variety of live potted blooming plants for the students to examine as they identify the parts of the plants and the corresponding terms such as root, stem, leaf, flower, seed, and seed coat. Students are encouraged to lift their plants from the pots to touch and identify the various parts. Then, in pairs, they draw their particular plant, and compare it with another pair's plant. These drawings, in addition to other learning products, are entered into student portfolios and serve as authentic assessments that Ms. Anderson uses to determine what students have understood (and possibly misunderstood) about the lesson.

Ms. Anderson motivates her students by sharing her own excitement for the lesson. She also uses anticipatory techniques such as asking students to guess what part of a plant she might be holding behind her back or partially revealing a plant part for them to identify. She also enthusiastically asks students, "Are you ready for my next question?" She encourages students to clap when others contribute valid responses, and she verbally reinforces those responses.

During the course of the lesson, Ms. Anderson suggests a series of relevant problems for the students to solve. For example, she explains that some types of plants need less sunlight than others, and she uses one of their classroom plants, an African Violet, as an example. She then asks her students to help her determine the spot where the plant would receive just the right amount of sunlight for it to thrive. She playfully personalizes the plant, appearing to capitalize on the anthropomorphism and animism that characterizes the scientific thinking of pre-operational children (Ginsburg, 1997; Piaget, 1951), while at the same time being careful to ensure that the children do not form misconceptions about plants.

Ms. Anderson's lesson is motivational as well as informative. She integrates the CTL strategies with the content, and the children are clearly engaged. When asked about her philosophy of teaching, Ms. Anderson explained that the CTL strategies help her children learn and apply knowledge better than traditional drill, practice, and memorization strategies. Regarding the impact of the CTL strategies on the students' learning about plants, she happily said, "If I ask them next year to identify and show me the parts of a plant, chances are they will be able to do it!" This comment and others by Ms. Anderson reflected her thinking that CTL was a more constructive and meaningful approach to instruction than the traditional approach that she had learned earlier in her career. The traditional approach, as she described it, was one that emphasized rote learning, a process that she now wanted to avoid. CTL, as she explained, provided her with an approach that made science relevant to her students' lives.

Case 2: Ms. Jeanne Morton, Baker Elementary School, 2nd Grade

Baker Elementary School is an urban school in an older historic section of the city. There are 418 students enrolled in grades Pre-K through 5th grade, of whom 49% are Anglo American, 32% are African American, 10% are Asian American, and 8% are Hispanic/Latino American. About 5% of the students have limited English proficiency. There are approximately equal numbers of boys and girls at Baker. About 44% of its students come from low-income families and qualify for a free or reduced price lunch, according to federal guidelines. About 14% qualify for special education services.

Ms. Jeanne Morton is an Anglo-American woman in her early forties who has been a teacher for more than ten years, two of them at Baker. In Ms. Morton's classroom, there are displays on every wall, there is a 50-gallon fish tank gurgling softly in the corner, the windows have colorful butterflies posted on them, there are posters of all sorts throughout the room, and books fill every available space.

At 9:45 AM, in connection with a lesson on butterflies, the daily "power walk" begins. Students go outside to the butterfly garden and play area, bringing their snacks. The students are energetic, inquisitive, and attentive. Ms. Morton stimulates inquiry by directing the students to "look for something, alive or that once was alive, that has changed since we went outside yesterday." Following this, students go back into the building, after individually telling Ms. Morton what they have "discovered," which is her "secret password" to re-enter the building. Students then collaboratively work on problems and projects, including constructing butterflies out of craft materials in accordance with the information learned earlier, comparing butterflies to moths and other living things. These models of butterflies, along with other work products, are placed in student portfolios and used by Ms. Morton as authentic assessments of what her students have learned from the lesson. The portfolios are available to parents so that they can see the nature and quality of the work their children are producing.

At 10:45 AM, classes change, and Ms. Morton's reading group comes in. The story in the text is about fossils, so Ms. Morton has worn amber jewelry which she passes around and discusses. She also has brought a lamp from home that has a clear glass base filled with fossils that the children inspect.

Ms. Morton's enthusiasm is in itself motivational—in response to it, students seem to want to please her. She also uses many types of colorful materials and gives each student sticky notes on which to list new scientific words. When a student responds appropriately to a question she poses, she praises him or her, saying, "That is a great start! Who would like to add on?" Other students eagerly do so, resulting in a set of responses from which all students learn. She encourages her students to touch the fossils and develop their observational skills. The arrangement of student desks lends itself to cooperative learning, with the desks set up in squares, and with each group of four students facing in with their desktops making one "table." Ms. Morton uses this arrangement in other activities as well.

Much of Ms. Morton's teaching is inquiry-based. Outside her classroom door, a poem is posted that poses questions about a butterfly. All students have reflected on it and can answer questions about it. Ms. Morton frequently asks a series of questions, with one question evolving from another. She uses questioning to prompt students to be resourceful in their creation of insect models: "We don't have enough pipe cleaners for everyone to get six, but you can have three; how can we make six butterfly legs out of three pipe cleaners?" Ms. Morton's frequent use of CTL strategies was consistent with the philosophy of science teaching that she shared with us:

> I believe that students are ultimately driven to make sense of their physical environment, and the more tools and opportunities that we give them to interact with science and the real world around them, the more they will pursue that knowledge as they grow and learn.

This statement, along with others of a similar nature, suggested that Ms. Morton thought of CTL as a tool for achieving one of her primary goals—to help her students embrace science as a way of knowing the world around them. Given the diversity of her students, and the fact that many of them came from economically disadvantaged circumstances, she felt she must be as proactive as possible in fostering an appreciation of science in them. This goal was achievable through CTL, according to Ms. Morton, and this was the reason she gave for valuing CTL so highly.

Case 3: Ms. Alicia Roberts, Taft Elementary School, 4th Grade

Taft Elementary School is located in a suburb. There are 429 students enrolled in grades Pre-K through 5th grade, with approximately equal numbers of boys and girls. Taft is a very ethnically diverse school: 40% of the students are Anglo American, 8% are Hispanic/Latino American, 43% are African American, and 7% are Asian American. About 43% of Taft's students come from low-income families that qualify for a free or reduced price lunch under federal guidelines. About 11% of the children qualify for special education services.

Ms. Alicia Roberts is an African-American woman in her late twenties who has been teaching children for seven years, all of them at Taft School. She has a B.A degree in early childhood education. Ms. Roberts has a well decorated classroom; it is neat, organized, and attractive. There is a door leading out to a butterfly garden. Within the classroom, there are four clusters of six desks, with sets of multicolored paper Chinese lanterns hanging over each cluster, multiple bright posters on the walls, and two bulletin boards labeled "Our Best Work."

The 24 students in Ms. Roberts' class include eight African Americans, one Asian American, one Hispanic/Latino American, one Eastern Indian American, and 13 Anglo Americans. The students are active and attentive, occasionally getting so energized by a task that they have to be gently reminded to calm down.

Ms. Roberts begins her lesson about food chains and food webs by reading aloud to the students an excerpt from the book *There Was an Old Lady that Swallowed a Trout*. She then reviews relevant technical terms previously learned by the students and explains some new ones (e.g., ecosystem, producer, consumer, decomposer, omnivore, carnivore, herbivore, scavenger). Students are divided into groups of five and are given a variety of problems and projects to work on collaboratively. For example, the students are given relevant terms on cards and asked to alphabetize them quickly. Next, they are given definition cards and are asked to collaboratively match them up with the terms. Then, Ms. Roberts reassigns the groups and gives each student a card with the name of a living thing (e.g., grass, caterpillar, snake) on it. The students in each group are then given the task of making themselves into a plausible food chain, drawing it, and later placing their drawings in the portfolios that Ms. Roberts uses for authentic assessment.

Later in the lesson, Ms. Roberts asks all the students to form a circle. She enters the circle and goes to its center, declaring herself to be “the sun.” She then holds onto a piece of yarn as she passes the yarn ball to “something or someone” that depends on her to make its food (in this case, grass). The ball continues to crisscross the circle until the students complete a food web. She explains that a food web consists of the many overlapping food chains in an ecosystem. After the students have all done this, Ms. Roberts reminds them of the story of *There Was an Old Lady that Swallowed a Trout* and helps them to reflect on how it represents a food chain.

Throughout the lesson on food chains and food webs, Ms. Roberts uses a variety of manipulatives and activities, encouraging the students to work cooperatively on their problems and projects. She encourages relevant discussion among her students through reflective questioning. She allows her students to decide how to best accomplish component tasks. Some of the large group activities, such as making a comprehensive food web, require the cooperation of the entire class to complete successfully.

This lesson is taught by Ms. Roberts with confidence and enthusiasm. The students are engaged and on-task. She uses a classroom management system that emphasizes students being responsible for themselves and each other. The system works, does not interrupt the flow of the classroom, and seems to be quite effective in providing a framework for the use of CTL strategies. When asked about her philosophy of teaching, Ms. Roberts replied,

> I enjoy teaching all subjects, and I like to use a lot of cooperative learning in my classroom. I truly feel that students learn best from each other, so I try to incorporate a lot of small-group and hands-on activities for them. It helps them to retain the information they are taught, and it keeps learning fun for us all!

These comments and related ones made by Ms. Roberts reflected the value she placed on the democratic goals of education. Cooperative learning, mutual respect, and human rights were fundamentally important to her and represented themes that emerged in her discourse. Her emphasis on democratic education is particularly noteworthy because her class was among the most diverse of those of the participating teachers. Ms. Roberts’ comments suggested that she thought of CTL as a means for preparing her students not only in the area of science, but for a life consistent with democratic values—a life of cooperation and mutual respect for all members of society.

Discussion

The case studies of the 21 teachers provided considerable insight into the conditions that facilitate and hinder the implementation of CTL strategies when teaching science in elementary schools to diverse groups of children. Most of the teachers used the CTL strategies well and often, as exemplified by Ms. Anderson, Ms. Morton, and Ms. Roberts.

One condition that facilitated the implementation of CTL strategies was the mode of interaction with students. CTL strategies were most easily implemented when teachers treated their students as collaborators in the learning process.

Teachers "collaborated" with their students by sharing decisionmaking with them and respecting the decisions their students made, which empowered their students and promoted autonomous learning. Often, these collaborations involved subgroups of students working together, assisting in each other's learning and monitoring each other's progress and products. Because the students in these classes are diverse, collaborative learning can have long-lasting, positive social consequences.

A second condition that facilitated the use of CTL strategies was the activity level of the lessons. CTL strategies were most easily implemented when teachers ensured that their students learned in an active, hands-on fashion and discovered knowledge through their own initiatives.

The teachers discouraged rote learning in their students and fostered inquiry, often using Socratic questioning to stimulate higher-order thinking and problem solving when investigating natural phenomena.

A third condition that supported the use of CTL strategies was connection to real-world contexts. Real-world contexts were accessed by going outside to make observations and by bringing live plant and animal specimens into classrooms. When the students were given opportunities to look for living things and put their hands in soil, they became more engaged, attentive, and receptive to the content and the use of the CTL strategies. The real-world contexts did not need to be elaborate to be effective, as long as they were perceived by the children to be relevant to the lessons.

A fourth condition that facilitated CTL was integration of science content with other content and skill areas. Students were induced to call upon their knowledge of mathematics, social studies, and literature—and use their oral, written, and artistic expression skills to successfully complete their "authentic" projects. The teachers profiled here used the CTL strategies to integrate science content with other content and skill areas. For example, Ms. Anderson's lesson on plants, Ms. Morton's lesson on butterflies, and Ms. Roberts' lesson on food chains and webs all incorporated inquiry, cooperation, problems, projects, and authentic assessments.

There were conditions that were found to hinder the implementation of CTL strategies. Among the 21 teachers observed, some had difficulty using CTL when particular classes acted in a manner which can be best described as unruly. When CTL strategies were not used in conjunction with sound classroom management practices (Loucks-Horsley et al., 2003), then students who were not accustomed to working collaboratively on problems and projects redirected their energy into nonproductive acting-out behavior or "horseplay." These students sometimes engaged excessively in irrelevant side conversations, complained about the other members of their groups, mishandled materials for the activities, and bumped or pushed one another.

A related condition that hindered the use of CTL strategies was the manner in which misbehavior and off-task behavior was dealt with by a teacher. When a student was punished by loss of grade points or time out for misbehavior, this tended to undermine CTL. The most effective teachers were those who anticipated management problems and avoided them by prominently posting their policies (illustrated with graphics) around their rooms. The most effective teachers also helped their students to cooperatively monitor their own (and others) behavior and, thereby, avoid off-task behavior. For example, on one occasion in Ms. Anderson's class, one of her students, Brad, got up during a cooperative activity and headed off, away from his group, to play with some objects that were distracting him. Ms. Anderson theatrically and comically put up her hand to shield her eyes from the wayward student and whispered to the class, "Oh, Goodness! Brad should be with his group! Don't let me see him! Hurry, help him get back to his group!" Several of his fellow students called to Brad and encouraged him to return to his spot which he did. By prompting her students to monitor one another's behavior in a positive fashion, Ms. Anderson helped all to stay on task.

Conclusion

In conclusion, the case studies of teachers reported here indicate that a number of conditions foster the implementation of CTL strategies when teaching science in elementary schools. These conditions included a collaborative interaction with students, a high level of activity in the lesson, a connection to real-world contexts, and an integration of science content with other content and skill areas. Furthermore, the CTL strategies were best implemented when teachers used them in conjunction with sound classroom management techniques. Taken together, the findings of these case studies support the view that the implementation of CTL strategies can help elementary school teachers meet the challenges that confront them when teaching science to children.

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