Background Research Paper No. 3

What are the understandings of fifth grade teachers about teaching the concept of chemical change to their students?

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This study investigated seven fifth grade teachers who taught science classes in an intermediate school. The school had 18 fifth grade teachers, with ten of those teachers teaching the 18 classes of fifth grade science. Seven teachers who taught science to approximately 350 fifth grade students participated in the study.

One goal of the study was to investigate whether the teaching of chemical change by these teachers aligned with the National Science Education Standards which state that substances react chemically in characteristic ways with other substances to form new substances with different characteristic properties.

A Content Representation (CoRe) was used with these teachers. The CoRe represents a teacher’s way of teaching the concept of chemical change. The Content Representations (CoRe) were combined to include information taken from each individual Content Representation (CoRe) as well as information from the instrument, Pedagogical and Professional-experience Repertoire (PaP-eR) of each teacher. Categories for seven of the eight CoRe questions emerged from the data.
The first CoRe question asked what the teachers intended the students to learn about chemical change. It addressed what the teachers identified as the “big idea” in chemical change. The categories were (1) to distinguish between physical and chemical changes, (2) in a chemical change new substances are produced, (3) knowing that changes happen in our world, and (4) temperatures affect chemical changes. Five of the seven teachers stated that they intended the students to learn the difference between physical and chemical changes. Three stated that something new is formed in a chemical change. One stated that it was important to know that changes happen, and another teacher stated that temperatures affect chemical change and chemical changes affect temperature.

The second CoRe question asked why it was important for the students to learn about chemical change. Teachers gave five basic reasons supporting why students should learn about chemical and physical changes. Six of the seven teachers thought it was important to learn because it was practical, and students would need it in the future. Three cited safety reasons. Two stated that chemical change related to other science ideas. Three stated that it was dictated by the curriculum. One said it was important to help students’ interest levels in science.

The third CoRe question delved into the teachers’ content knowledge of physical science. The question asked whether there was anything else about this idea that they knew but would not expect students to learn yet. Four of the seven teachers stated that their knowledge level in regard to this concept did not go much further than what they planned to teach. One teacher commented that she did not expect students to know that a solid can change to a gas (sublimation) and skip one of the three states of matter. This teacher, however, ended up teaching that concept using dry ice.

The fourth CoRe question sought to determine any difficulties or limitations connected with teaching this concept. Self-efficacy, student behavior, materials, student diversity, time constraints, classroom space, and safety were mentioned as difficulties and limitations. Six of the seven teachers were not comfortable teaching chemical change or stated they lacked experience or the content knowledge needed to teach this concept. Only one teacher said he was very confident when teaching physical science. Three teachers mentioned student behavior as a limitation, three stated that the knowledge level of students could be a difficulty, two mentioned time as an issue, three mentioned the physical setting of the classroom, and one mentioned that safety issues could be a limitation.

The fifth CoRe question sought to capture the teachers’ knowledge about students’ thinking. The question also explored how they used that knowledge to teach the concept of chemical change. The teachers stated that students need hands-on activities and that teachers must relate to students. Teacher One said she used past experiences to decide what had worked and what had not worked as well with the students, and the first-year teacher used this year’s experience to think about the next year’s teaching of the concept. One teacher mentioned breaking the concept down into several important ideas the students should learn and using simple things to get those ideas across. Another teacher stated that students needed to record information so that they could look back and see it
later. All seven teachers acknowledged the importance of knowing the group of students whom they were teaching. Teachers talked about meeting the needs of special education students, English Language Learners, and gifted or higher level thinkers.

The sixth CoRe question asked the teachers if there were other factors that influenced their teaching of this concept. A lack of ideas, behavior, safety, teaching methods, space, available resources, personal real-life experiences, the curriculum, the availability of special education teachers, and volunteers were mentioned as factors influencing teachers. One teacher stated, “Everything influences how I teach.”

The seventh CoRe question covered the teaching procedures of the teachers. All of the teachers started off with discussions of physical and chemical changes and then used demonstrations, activities, or hands-on experiments to show the students the difference between physical and chemical changes. One teacher discussed the two types of changes and then demonstrated how temperature affects the rate of a chemical change. All teachers had varying degrees of discussion after the activities. The science book was not used by all of the teachers, and no teacher exclusively used the book. When teachers did use the book, it was for reading the definitions of chemical and physical changes.

The eighth and last CoRe question sought to get the teachers to describe specific ways of making sure the students either understood the concept or were confused about the concept. The question also wanted the teachers to give a possible range of responses from students. Four teachers mentioned that classroom observations helped them determine understanding. All seven teachers confirmed that questions and discussions in the classroom helped them determine understanding or confusion. The questions would be teacher or student oriented. Six of the seven teachers used some type of written assignment: lab sheets, workbooks, worksheets, notebooks, questionnaires, and review sheets. Two teachers had students write down examples of physical and chemical changes from home. Written tests or quizzes were mentioned by six of the teachers as a way to assess the students. Two stated that a test would be on a whole chapter, not just on physical and chemical change. No teacher gave possible student responses.

In summary, the teachers gave similar responses for many of the questions. They all taught differences between physical and chemical changes. They all stated that chemical changes resulted in new substances, but this part of the concept was not covered in the actual teaching or in the activities. The teachers were asked to teach chemical change, but all of the teachers taught about the differences between physical and chemical changes. All teachers reported that it is important to know about chemical changes for practical and safety reasons in the students’ everyday lives. The teachers were concerned about safety issues, classroom space, time, the diversity of students, students’ behavior, and a lack of materials when teaching chemical change. But, the biggest concern with teaching chemical change was the teachers’ own self-efficacy. They were concerned about their lack of knowledge, experience, and lack of collected activities. All seven teachers discussed the necessity of knowing their students and their learning differences. The teachers identified a variety of “other” factors that influenced their teaching: lack of ideas, behavior, safety issues for the students, having help in the classroom, curriculum,
classroom space, resources, and time. The teaching procedures used included lectures, demonstrations, hands-on activities, questioning, class discussions, and videos. All of the teachers used activities that were not in the science textbook. The most dominant way in which these teachers assessed the students was through oral questioning and discussion. Other ways to assess understanding or confusion were through observations, written assignments, and tests.

References


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