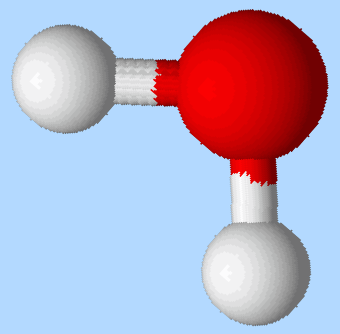
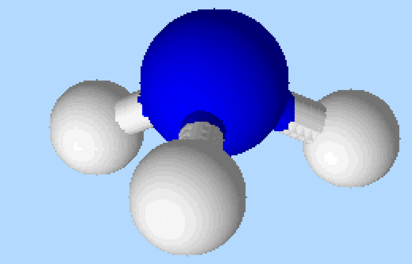


Impact of Process-Oriented Guided Inquiry Learning (POGIL) on Chemistry Students



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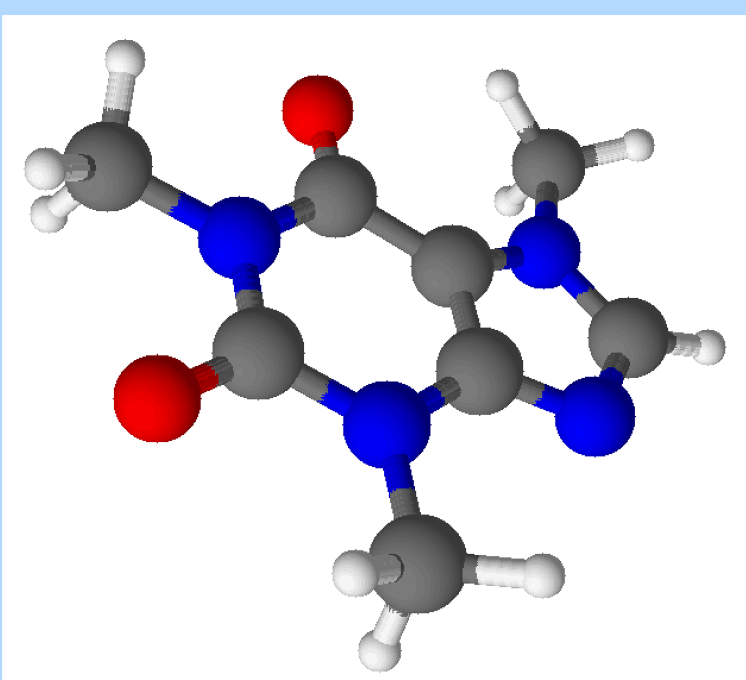
ABSTRACT

This classroom research project explores the use of guided inquiry and inquiry-based lab activities with college-preparatory chemistry students. The effects of such instruction on student achievement and content comprehension is explored. Also, the effect of cognitive development on student achievement is examined, as well as how students may be aided in their development from concrete toward formal thought. Results showed that concrete thinkers require specific methods of instruction both for science content and in order to aid their cognitive development.



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INTRODUCTION

Success in learning science rests in large part on a student's ability to think formally, or abstractly. In my study I attempt to discover the extent to which my work with students helps them to develop their formal reasoning skills. I am interested in this topic as a result of teaching both our college-preparatory chemistry course and the Advanced Placement Chemistry course. There is a big difference in these two populations because the first consists mainly of students who have not yet developed or who have only partly developed their formal reasoning skills. They are very concrete in their reasoning and frequently are unable to explain their reasoning when asked to explain how they know something. By teaching using a learning cycle of exploration, concept introduction, and application, and by using a small-group in-class work process known as POGIL (Process Oriented Guided Inquiry Learning) I hoped to have a positive impact on students' formal reasoning skills. In my study I measured this impact and used the results to reflect on my teaching practice.

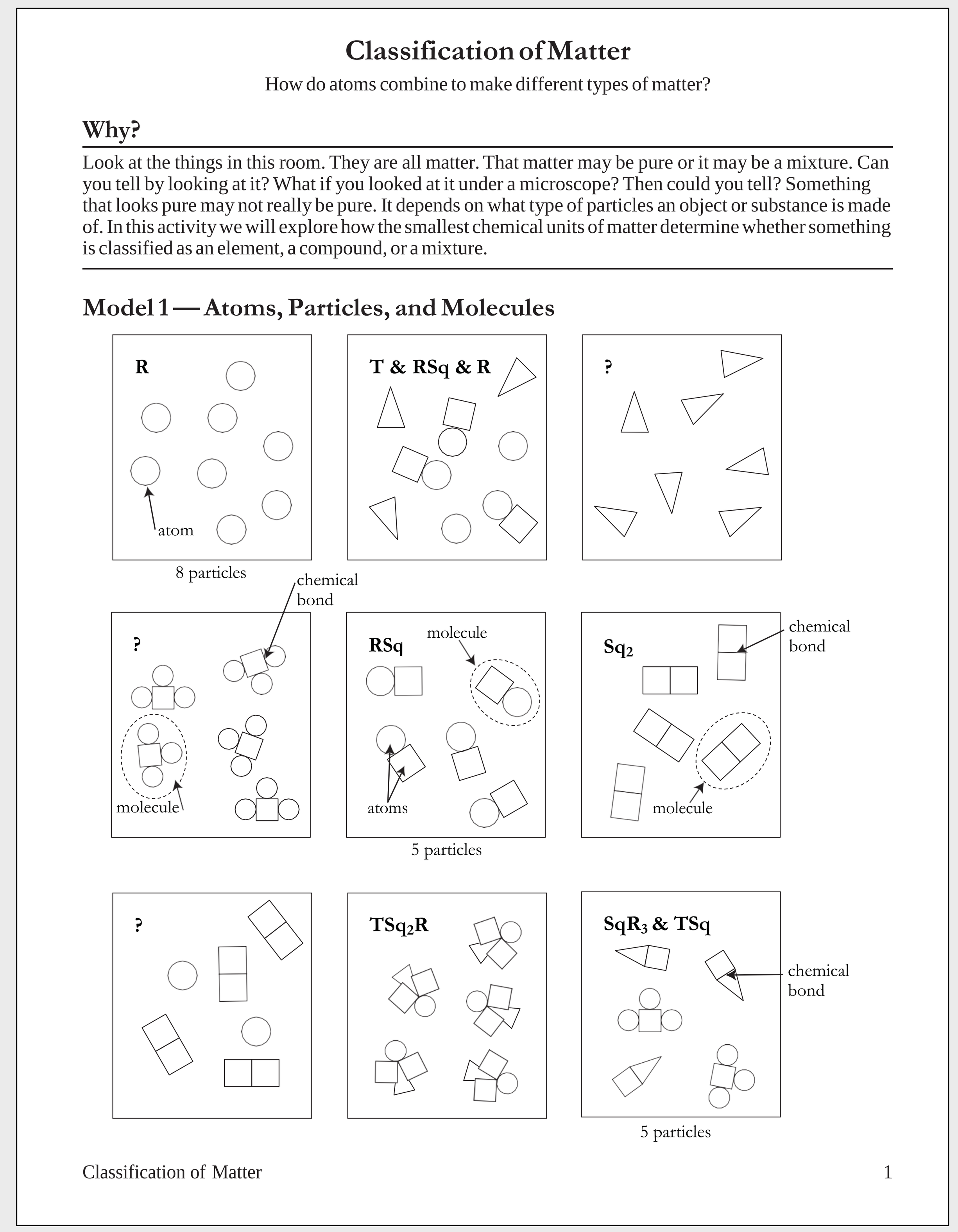
RESEARCH QUESTIONS

How does my work with students, including an implementation of the POGIL teaching method and inquiry-based lab activities, contribute to their growth in developing from concrete thinkers toward formal reasoners?

1. How does the use of POGIL and inquiry-based lab activities affect students' development of reasoning skills?
2. How does a student's initial measured level of reasoning skills affect comprehension of science content?
3. How does the use of POGIL affect students' own evaluation of their success in chemistry?
4. How does my reflection on my practices with respect to the aim of developing students' formal reasoning affect my approach to teaching?

METHODS

As a central part of my teaching I ask students to work together in small groups to construct their own understanding of the material in the unit. The groups are heterogeneous and teacher-selected. Students had defined roles such as Manager or Reader and they were given the task of working through the carefully designed materials.



Classification of Matter

How do atoms combine to make different types of matter?

Why?

Look at the things in this room. They are all matter. That matter may be pure or it may be a mixture. Can you tell by looking at it? What if you looked at it under a microscope? Then could you tell? Something that looks pure may not really be pure. It depends on what type of particles an object or substance is made of. In this activity we will explore how the smallest chemical units of matter determine whether something is classified as an element, a compound, or a mixture.

Model 1 — Atoms, Particles, and Molecules

Fig. 1 Sample page from a POGIL activity

Questions which follow this model require students to examine the it carefully. The patterns and relationships shown in the model are discovered by the students, who are guided to form appropriate conclusions.
To collect data about reasoning skills I used the Lawson Classroom Test of Scientific Reasoning (LCTSR).
I compared student scores on this test with their pretest and posttest scores as well as summative assessments.
The LCTSR places students into one of four categories: Concrete, Early Transitional, Late Transitional, and Formal. These terms were first introduced by Jean Piaget

RESULTS

Results of the LCTSR test showed that 87% of students were either concrete or early transitional reasoners. The better the existing reasoning skills of the student, the better the student performed on assessments, even though not tested directly on reasoning ability.

	No. of Students	Percentage of Students
Concrete	17	46%
Early Transitional	15	41%
Late Transitional	5	14%
Formal	0	0%

n=37

Fig. 2 Classroom Test of Scientific Reasoning Results

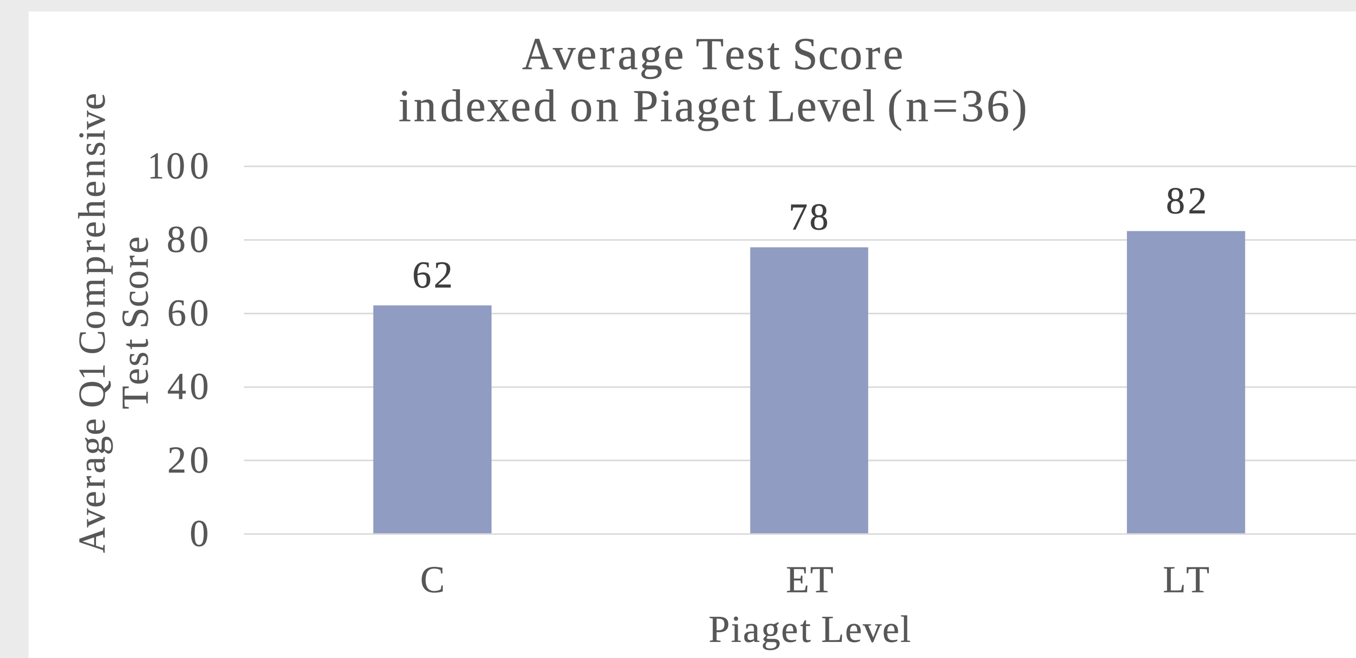


Fig. 3 LCTSR categories compared with quarter 1 comprehensive test scores

The use of POGIL, inquiry-based laboratory activities, and a learning cycle approach to teaching new material did not lead to much gain in terms of reasoning ability. In fact, when the LCTSR was given again after several months of instruction it was found that most students remained in the same reasoning category. Still, it is valuable to note how important reasoning skills are with respect to learning new material in science.

LCTSR Score Changes from Pretest to Posttest, (N = 31)

	No. of Students	Percentage of Students	Average Normalized Gain
Moved to the next category down	5	16%	-0.26
Remained in the same category	19	61%	-0.01
Moved up to the next category	7	23%	+0.33

Fig. 4 LCTSR Pretest vs. Posttest Results