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ABSTRACT

This study investigated the academic achievement of students at the end of the school year in knowledge of gravity, acceleration, and the relationship between distance, time, and speed. The students' teachers were in the Cheche Konnen professional development seminar for three years. Participating grade levels included a heterogeneous, combined 1st/2nd grade elementary classroom, a combined 5th/6th grade Haitian Creole bilingual classroom, and a heterogeneous 7th grade science class. (Contains 10 references.) (YDS)

Professional Development and Children's Understanding of Force and Motion: Assessment Results[1]

Chèche Konnen Center
TERC
Cambridge, MA
Ann S. Rosebery and Beth Warren, PIs

Introduction

The Chèche Konnen[2] Center at TERC is collaborating with 12 school districts across the country to establish programs of professional development in science for teachers of low-income, ethnic and linguistic minority students. These include students who receive free or reduced lunch, recent immigrants, students from homes where English is not spoken, and students from families with little formal schooling. The Center works with teachers and administrators to develop and implement programs of professional development designed to 1) deepen teachers' understanding of the ideas and knowledge-making practices of scientific disciplines, and 2) use this understanding together with practices of teacher-research to enhance their ability to listen to, make sense of, and build on the diverse ideas and ways of talking that children from diverse linguistic and cultural backgrounds bring to science.

Background

In past and current work, we have studied the effects of our professional development program on children's learning through tasks and interviews we have designed and through analyses of classroom discourse (Ballenger, 1997; Conant, Rosebery, Hudicourt-Barnes, & Warren, in press; Rosebery & Puttick, 1998; Rosebery & Warren, 1998; Rosebery, Warren & Conant, 1992; Warren, Ballenger, Ogonowski, Rosebery & Hudicourt-Barnes, 2000; Warren & Ogonowski, 1999; Warren & Rosebery, 1996; Warren, Rosebery & Conant, 1994). Recently, we have been asked by teachers, administrators, policymakers, and other educators if students' experiences in Chèche Konnen classrooms, which are designed to be responsive to children and responsible to scientific disciplines (Ball, 1997), prepare them to do well on standardized and "high stakes" achievement tests. In 1999, we conducted a study to address this question. Specifically, we assessed the achievement of students in the classrooms of four teachers who participated in the Center's professional development program in Cambridge, MA.

These teachers participated in the study because they were required, as part of Cambridge's district-wide science framework, to teach a unit on motion or motion and force, a domain of ideas they had studied in some depth in the professional development seminar. As part of the study, each teacher taught a unit s/he developed on aspects of motion and force, including a focus on kinematics and/or Newton's Laws. The design of the units was based on curricula adopted by the district as well as on the teacher's own experiences in the professional development seminar. Units varied in duration from several weeks to several months. The following classrooms participated: a heterogeneous combined $1^{st}/2^{nd}$ grade elementary classroom; a heterogeneous combined $3^{rd}/4^{th}$ grade elementary classroom; a combined $5^{th}/6^{th}$ Haitian Creole bilingual classroom; and a heterogeneous 7^{th} grade science class. At the time the study was conducted, the teachers had participated in the Chèche Konnen professional development seminar for three years.

Method

To assess students' achievement at the end of the school year, we administered selected problems from an assessment item bank on motion and force, which includes problems from a variety of "high profile" achievement tests and high quality curricula (e.g., the Third International Mathematics and Science Study (TIMSS), the Massachusetts Comprehensive Assessment System (MCAS, the Massachusetts state achievement test), the National Assessment of Educational Progress (NAEP), and Cambridge Physics Outlet (CPO)). For this study, we chose five items that were written to test students' knowledge of gravity, acceleration, and relationships among distance, time and speed, concepts the students had studied. All of the items were originally designed for use with 7^{th} and 8^{th} graders and were multiple choice in format; some were revised slightly so young students could read them. All problems were administered in writing. (N.B. One of the problems was translated into Haitian Creole for students in the $5^{th}/6^{th}$ bilingual grade class. Two of the problems were read aloud to a few first grade students who could not read them. Copies of the original problems and our revised versions are available upon request.)

Results

A mean of 86% of students answered the problems correctly, with grade level means ranging from 74% to 100%. Students in each grade performed at high levels on all items, notably outperforming the international results for 8^{th} graders for both TIMSS problems. The percent of students at each grade level who answered each problem correctly as well as means across grade levels are reported in the table below.

Percent of Students Who Answered Correctly

Chèche Konnen Results						TIMSS International Results
Problem	1st/2nd Graders	3rd/4th Graders	5th/6th Graders	7th Graders	Mean Across Grade Levels	
1. TIMSS Gravity (7th/8th Gr)	83% (19/23)	83% (20/24)	88% (14/16)		**84% (53/63)**	49% - Gr 7 55% - Gr 8
2. MCAS Gravity (8th Gr)		96% (23/24)	100% (16/16)		**98% (39/40)**	
3. CPO Acceleration (8th Gr)	78% (18/23)				**78% (18/23)**	
4. TIMSS Distance, Time, and Speed (7th/8th Gr)				90% (17/19)	**90% (17/19)**	78% - Gr 7 83% - Gr 8
5. MCAS Distance, Time, and Speed (8th Gr)				74% (14/19)	**74% (14/19)**	
Mean across all problems and grade levels					**86% (141/164)**	

Discussion

These results show that the children in the four Chèche Konnen classrooms that participated in the study attained high levels of achievement in science according to the benchmarks established by standardized and "high stakes" achievement tests. In this regard, it is important to remember that more than half of these children were from low income or working class households, households with little history of formal schooling, or households in which English is not spoken as a first language. We take these results, along with our ongoing analyses of classroom interaction and of students' scientific reasoning and discourse in other assessment contexts, as evidence of the effectiveness of an approach to professional development which integrates teacher inquiry in science with inquiry into children's ideas and ways with words in science. The teachers in this study, who had opportunities to learn about the phenomenon they were teaching as well as opportunities to think about their students' conceptual understanding and ways with words, were able to create classrooms in which students learned with understanding and performed well on achievement tests.

[1] The work reported herein was funded by a number of agencies including the National Science Foundation (ESIE No. 9555712) and the Office of Educational Research and Improvement, U.S. Department of Education, through the Center for Research on Education, Diversity and Excellence at the University of California, Santa Cruz (CREDE, Cooperative Agreement No. R306A60001-96) and the National Center for Improving Student Learning and Achievement in Mathematics and Science at the University of Wisconsin, Madison (NCISLA, Cooperative Agreement No. R305A960007). The views expressed in this summary do not necessarily reflect those of the funding agencies.

[2] Chèche Konnen means "search for knowledge" in Haitian Creole.

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Appendix

1) TIMSS "gravity" problem
    a) original problem, designed for 7th and 8th graders
    b) revised version used with 1st and 2nd graders
    c) revised version used with 3rd and 4th graders
    d) version translated into Haitian Creole for use with 5th and 6th graders

2) MCAS "gravity problem
    a) original problem, designed for 8th graders
    b) revised problem version used with 1st and 2nd graders

3) CPO "acceleration" problem
    a) original problem, designed for 8th graders
    b) revised version used with 1st and 2nd graders

4) TIMMS "distance, time, speed" problem
    original problem used, designed for 7th and 8th graders

5) MCAS "distance, time, speed" problem
    original problem used, designed for 8th graders

Answer Key:

1) D
2) B
3) the car will be moving fastest at the bottom of the ramp and slowest at the top of the ramp
4) B

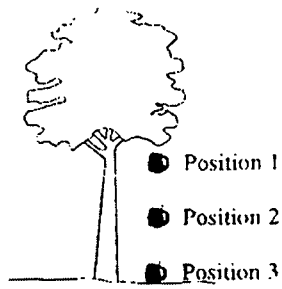
K17. The drawing shows an apple falling to the ground. In which of the three positions does gravity act on the apple?

A. 2 only

B. 1 and 2 only

C. 1 and 3 only

D. 1,2, and 3

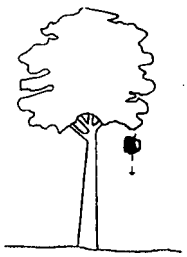


Subject	Item Key	Content Category	Performance Expectation	International Average Percent of Students Responding Correctly		International Difficulty Index
				Upper Grade	Lower Grade	
Science	D	Physics	Understanding Simple Information	55%	49%	571

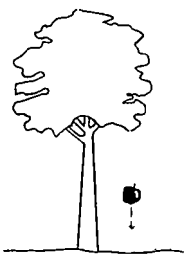
Problem 1a) original TIMSS "gravity" problem 7

Name_____ Date_____

The pictures show an apple falling to the ground.
Where is gravity pulling on the apple?



Is it pulling here?



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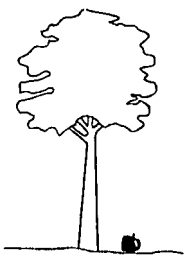
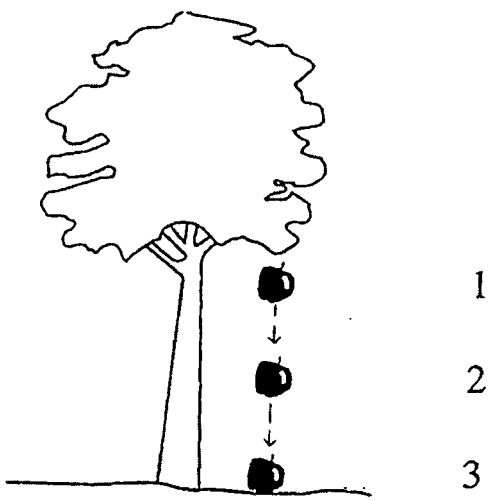


Is it pulling here?

Problem 1b) revised TIMSS "gravity" problem, used with 1st/2nd graders

8

The picture shows an apple falling to the ground.
Where is gravity pulling on the apple?



A. 2 only

B. 1 and 2 only

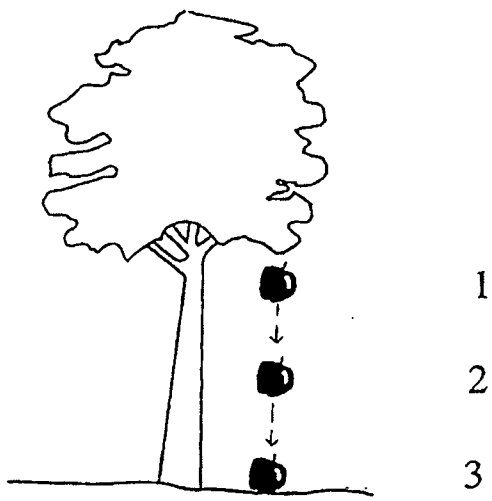
C. 1 and 3 only

D. 1, 2, and 3

Problem 1c) revised TIMSS "gravity" problem used with 3rd/4th graders 9

Desen an montre ou on pom k'ap tonbe.

Nan kiles pozisyon gen gravite k'ap rale li?



A. 2 only

B. 1 and 2 only

C. 1 and 3 only

D. 1, 2, and 3

Problem 1d) Haitian Creole version of TIMSS "gravity" problem used with 5th/6th graders

A ball is thrown straight up into the air with a velocity of 10 m/sec. What is the main reason that the ball will eventually slow down, stop, change direction, and fall back to the ground?

11

A. The friction of the air acts on the ball.

*B. Force due to gravity is opposite to its original motion.

C. No motion can continue indefinitely.

D. The ball loses part of its mass as it goes higher.

Problem 2a) original MCAS "gravity" problem, designed for 8th graders

The picture shows a ball that has been thrown straight up into the air.

The ball starts going up. It slows down.
It stops. It changes direction.
And it falls back down to the ground. Why?

A. The friction of air pushes on the ball.

B. Gravity pulls it back to earth.

C. No motion goes on forever.

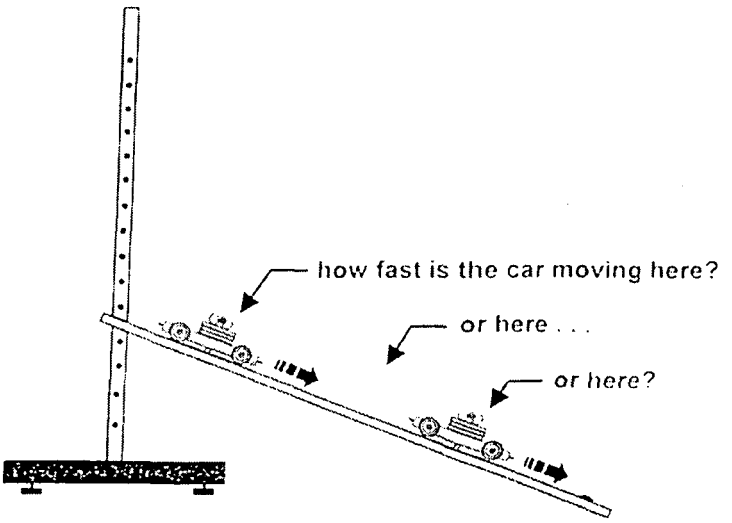
D. The ball loses some of stuff as it goes up

Problem 2b) revised MCAS "gravity" problem used with 3rd/4th and 5th/6th graders

ACCELERATION

In the last activity you measured the speed of the Car. You probably discovered that the speed was different in different places. This activity we will look a little closer at what happens to the speed of the Car as it rolls down the Ramp.

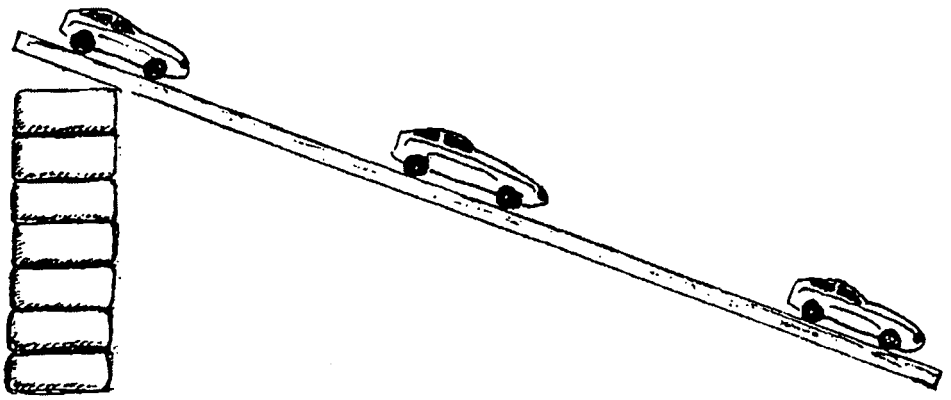
- **How do we describe the motion of the Car rolling down the Ramp?**



A2.1: Watch the car as it moves down. Where does it seem to be moving the fastest? Imagine the Car at the top, middle, and bottom. Write down where you think the Car will have the greatest speed.

Name:_____ Date:_____

What happens to the speed of a hotwheels car as it rolls down a ramp?



Imagine a hotwheels car as it moves down the ramp. Now imagine the car at the top, the middle and the bottom of the ramp. Write down where you think the car will have its top speed.

_____

_____

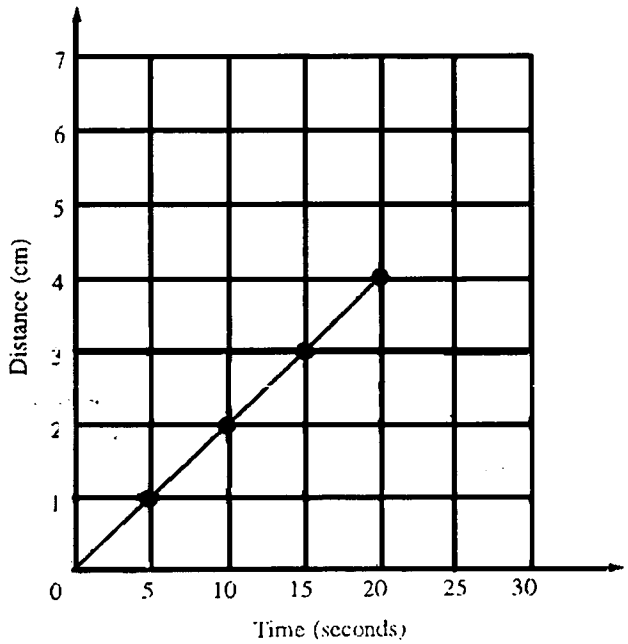
Write down where you think the car will have its slowest speed?

_____

_____

Problem 3b) revised CPS "acceleration" problem used with 1st/2nd graders

P1. The graph shows the progress made by an ant moving along a straight line.



P-1

If the ant keeps moving at the same speed, how far will it have traveled at the end of 30 senconds?

A. 5 cm

B. 6 cm

C. 20 cm

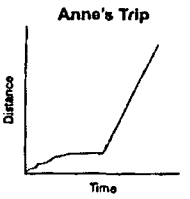
D. 30 cm

Subject	Item Key	Content Category	Performance Expectation	International Average Percent of Students Responding Correctly		International Difficulty Index
				Upper Grade	Lower Grade	
Science	B	Physics	Using Tools, Routine Procedures, and Science Processes	83%	18%	358

Problem 4) original TIMSS "distance, time, speed" problem used with 7th graders (designed for 7th and 8th graders) 15

Session 3, Multiple-choice Questions

27. Anne traveled from her home to a friend's house. She constructed this graph to show the relationship between the time and the distance traveled.



Which description is most consistent with the graph?

A. Anne started her trip on a country road. She stopped for lunch just before getting onto a superhighway for the rest of her trip.

B. Anne drove briefly on a superhighway, then on a country road, and finished her trip on a superhighway.

C. Anne started her trip on a superhighway. She stopped for lunch just before getting onto a country road for the rest of her trip.

D. Anne drove briefly on a country road, then on a superhighway, and finished her trip on a country road.

Reporting Category/Subcategory for Item 27: Physical Sciences/Motion (p. 229)

Problem 5) original MCAS "distance, time, speed" (designed for 8th graders) problem used with 7th graders

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