I DO, AND I UNDERSTAND

Helping Young Children Discover Science and Mathematics

Robert Louisell

with special guest chapters by

Stephen Hornstein and Peter Frost

I hear, and I forget.
I see, and I remember.
I do, and I understand.

*Ancient Asian Proverb.

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and

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Constructivist Press
Minneapolis, Minnesota

For information about this book, contact:

Constructivist Press
P.O. Box 24502
Minneapolis, MN 55424
www.constructivistpress.com

Cover photos by Robert Louisell

Book layout, design, and typesetting
by Peter Lilliebridge

'Cross the Lilliebridge™
www.crossthelilliebridge.org

Printed by
Sunray Printing Solutions
in St. Cloud Minnesota

SUNRAY PRINTING SOLUTIONS
www.sunrayprinting.com

10-digit ISBN 1-934478-36-9
13-digit ISBN 978-1-934478-36-3

Printed in the United States of America

7 6 5 4 3 2 1

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Author's Preface

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There are many ways that young children learn. They learn from observing. They learn from actively listening and from overhearing. Most of all, they learn from doing. This book has been written for future teachers of young children; that is, students of early childhood education or child development. It has been specifically designed for use in courses on how to teach young children about mathematics and science.

A young child's thoughts are intricately tied to her or his actions because the young child's thoughts have not yet been fully distinguished from the young child's actions in the child's mind. Chapters 2 and 3 attempt to explain why this is so. Some education texts include a chapter on children's "misconceptions," as does this text, but, as far as we are aware, no text actually deals with appropriate strategies for interviewing children and interpreting what they say. Chapters 2 and 3 were written to help prospective teachers of young children learn how to better get to know the ideas of the children with whom they work. This is an essential skill for constructivist teachers since they must anticipate, and respond to, the ideas of their students.

But the whole point of this book—its theme—is that young children best learn about math and science by *do*ing. What does that mean? *Do*ing? It means that they learn how to add by combining groups of objects and counting how many objects there are in the new group that has been formed as a result. It means that they learn about density by making clay boats and testing them to see if they float. It means learning about electricity by being given a battery, a bulb, and a wire and figuring out how to make the bulb light. It means learning how to divide by taking a group of objects—say, caramels—and dividing them equally among themselves.

In other words, young children need to *experience* mathematics and science if they are to learn it well. And they need to *understand* these experiences. Children can learn the procedure for addition—combining two or more groups of objects and counting up the result—but they must also understand this process! When it comes to the written symbols for mathematics, the child must realize that two or more groups are being combined every time she sees a "+" sign.

A child's curiosity must be nurtured during instructional experiences with math and science. Telling children the answers to science questions and showing them the most efficient ways to solve math problems does not nurture their curiosity about these subjects. If you always answer the child's questions about science, what reason does she have to explore these phenomena further? If you always show the child how to solve math problems, when will she ever develop her *own* ideas about math? We don't mean that a teacher should never show a child how to do something like add or subtract or that a teacher should never tell the child an answer to a science question, but this sort of showing and telling should be done sparingly. Mathematics and science must also be related to the real life experiences of children. Otherwise, how will young children ever become aware of the importance of math and science in the world in which they live and observe things? Why will children want to learn about math and science? They must see how it applies to their everyday lives. Chapters 10 and 11 deal with this issue—how math and science are related to our everyday lives as well as how they relate to other subjects.

Our philosophy of teaching science and mathematics to young children is constructivist (See Chapter 1 for our interpretation of this term). Some people think that knowledge can be transmitted—*taught*—to children. We believe, as Piaget did, that the young child *invents* her or his knowledge and understandings. Teachers can facilitate this process of invention through a variety of methods; for example, by providing young children with hands-on experiences and engaging them in discussions and debates about these experiences. Children come to school curious about many things, including science and mathematics. It's a shame that they often leave school less curious about these things because we see the development of the child's curiosity as a primary goal—an essential standard—for school science and mathematics.

Although most textbooks of this type typically start with theory and move to examples of best teaching practices, the first three chapters of this book may have "more than enough" theory for some! Professors may choose to deemphasize these chapters, although I do hope that they will at least engage their students in the activity of doing clinical interviews with children. In my own experience as a college professor, it provides early childhood majors with a much needed insight into the differences between how children and adults think. As my doctoral advisor, Jack Easley, said to me many times, the most practical idea is to have a good theory.

We wrote this book because previous texts on the subject of early childhood mathematics and science teaching omitted an essential aspect of the field. While they covered preschool and kindergarten years, they neglected the mathematics and science teaching for grade levels one through three. This book corrects that fault. It comprehensively deals with preschool/kindergarten *and* grades 1–3 and it contains over a hundred tested early childhood activities for mathematics and science. The *Activities for Children,* which are numbered in each of the chapters that include them, are intended for teacher-candidates as well as children. It is appropriate to demonstrate these during class time or to have students practice these activities independently. It is assumed that the practicing teacher will make her own judgement about whether any individual activity is best completed as a teacher-led, supervised activity or as an independent activity for children in small groups. In most cases, this should be obvious from the description of the activity.

There are a variety of boxed items in this text which have been provided for the benefit of the reader. These include *Activities for Children, Activities for Future Teachers, and Assessments.* It is assumed that the reader of this text will keep a student journal related to the activities for future teachers in the science-related chapters. Those *Activities For Future Teachers* that are science-related may be carried out independently by the reader at home or in class with other students, depending on the instructor's preference. We have also included boxes for relevant content standards; for example, NCTM *Principles and Standards, Benchmarks for Science Literacy, National Science Education Standards,* and *Next Generation Science Standards.*

In the chapters about the development of the child's understandings of mathematics (Chapters 4–6), you will find boxed items entitled *Assessment Activity;* for example, *Assessment Activity 4.1.* These are not intended as summative assessments. Rather, they should be considered formative in nature; that is, they are snapshots of "where the child is" in his or her development for this specific math topic at this particular point in time. No inferences about the child's capabilities in mathematics are appropriate here. Rather, these assessments are provided to help teachers acquire some insight into the child's ideas about this topic at a particular point in time so that the teacher can better decide how to teach this child.

Our philosophy of assessment favors authentic assessments for formative purposes. In other words, we believe that assessments should occur in the context of ongoing experiences in which the children are engaged. Reports about the educational progress of individual children should communicate what the child has learned, is learning, and is about to learn. We oppose grades or marks that compare students to each other, except for very general developmental "landmarks" that can help a parent to understand the nature of a child's special needs. We have not included any of the diagnostic assessments used for purposes of special education because many early childhood education programs are now combined with special education and courses in this area can deal more appropriately with this topic. We have, however, included some adaptations for special needs students in science during kindergarten and the primary grades.

We have opted for specific assessments in the form of boxed items rather than for dealing with the entire topic of assessment in a separate chapter on the topic. Readers who would like to know more about strategies for assessing the student's learning during early childhood and elementary school can be referred to Chapter 7 of our previous book, *Developing a Teaching Style–2e,* by Louisell and Descamps (Waveland Press, 2001).

Many future early childhood teachers are unconfident about their own knowledge of science content. The *Activities for Future Teachers* in Chapters 7–9 provide the reader with experiences that will help them develop knowledge related to content that they must teach in the primary grades; for example, *organisms* and *life cycles.*

Appropriate *internet resources* are provided throughout the text in the context of the topics being discussed. A DVD accompanies this text. As this book goes to press, it contains some examples of interviews with children. We hope to include videotapes from classroom math and science lessons, along with an introductory presentation about constructivist teaching, with the second printing.

This book represents the ideas of the primary author about the theory and practice of teaching science and mathematics to young children. He has developed these ideas over a period of over 40 years while teaching children and future teachers. He has tested almost all of the *Activities for Children* with classrooms of young children. We hope you will find this book useful.

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References

Louisell, Robert, and Jorge Descamps (2001). *Developing a Teaching Style–2e.* Prospect Heights, IL: Waveland Press.

Acknowledgements

When it was still in its early stages, Jack Mayala and Wally Ullrich reviewed Chapter 2. Frank Kazemek reviewed it at a more developed stage, as did Klaus Witz and Juan Pascual-Leone. Thanks to each of these persons for their constructive feedback.

A number of people reviewed Chapter 3 for me: Frank Kazemek, Muhammad Pervez, Louis Smith, Jan Boom, and Ullrich Müller. This was a difficult chapter to write (and read) and I'm grateful for the feedback I received from each of these people.

Marie Wardrop Louisell, a mathematics educator and my wife, reviewed Chapters 4, 5, 6, and 10. I made several changes based on her comments. She also drew sketches for Figures 9.6–9.9. I'm grateful for all of her labors.

Juan Pascual Leone reviewed Chapter 7, along with the section on constructivism in the first chapter. Frank Kazemek and Ken Kelsey also reviewed the section on constructivism at an earlier time.

Sally Benekee shared her thoughts, expertise, and essential references with me regarding project work.

Several of our graduate students generously shared their ideas and journal entries with us. They are credited in footnotes at appropriate places in the text.

I'm also grateful to Rebecca Louisell, my daughter, who completed the majority of the original illustrations and edited and organized the videos for the DVD that accompanies this book.

Peter Lilliebridge did the design and prepress work for the entire book, including the cover design—developing the icons for the *Activities* boxes, reworking several of the drawings used as illustrations, creating many of the figures, and editing or retaking photos. The quality of this work was stellar and the book's appearance is chiefly his doing.

Sunray Printing Solutions delivered the high quality printing and finishing of the book's pages and cover. They also provided the ISBN number for the book.

I'm also grateful to Julie Tangeman of Minneapolis Public Schools for allowing me to use the district's science center to consult various teachers' guides for early childhood science programs.

Frank Kazemek, Bob Stake, and Judith White provided me with much needed moral support during the period that I was writing this book. Their support helped motivate me to persist to the book's conclusion.

Photos for the book came from Wiltshire and Bristol in England and from graduate students in the early childhood education program at University of Texas, El Paso.

The book would not have been complete without the contributed writings of Steve Hornstein and Peter Frost. Their names also appear on the book's cover.

Finally, the ideas of Jack Easley, who is deceased, about children's thinking and the process of science and math education, influenced this textbook profoundly. I owe him a debt I never can repay!

About the Authors

Robert Louisell holds a doctorate in elementary and early childhood education from University of Illinois and is Professor Emeritus at St. Cloud State University. He has seven years of teaching experience in public schools at the early childhood level. He has taught in early childhood education programs at St. Ambrose University and University of Texas, El Paso, and in the elementary education program at St. Cloud State University. He is also the co-author of *Developing a Teaching Style* (Harper-Collins, 1992, Waveland Press, 2001).

Stephen Hornstein is a professor in the College of Education at St. Cloud State University. His special interests include authentic mathematics curriculum and assessments during the early childhood and elementary years. He is also a proponent of whole mathematics and he has served as president of the Whole Language Umbrella and as a math coach at Tse'ii'ahi Community School in Standing Rock, New Mexico. His international experience includes consulting in Nigeria.

Peter Frost has taught education courses at Bath College of Higher Education in Bath, England and at William Jewel College in Kansas. He also has several years of teaching experience in primary schools. He was CEO of the National Primary Trust, Director of the Gifted and Talented Academy, and Policy Adviser for Government of England during 2005–8.

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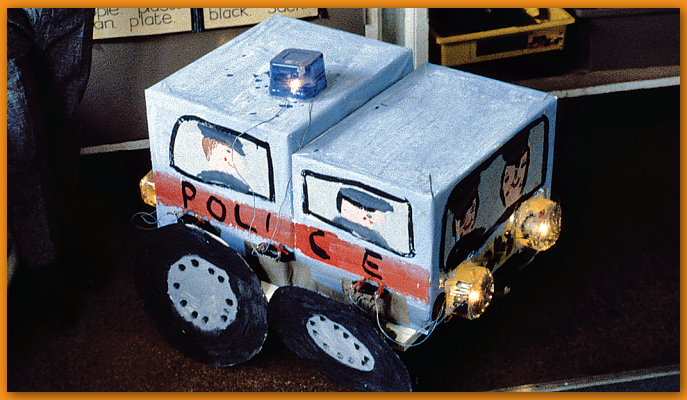
"A merit of his liberalized Piagetian approach is to help educators to take a subject's perspective about children as learners. These analyses of Dr. Louisell's yield wise advice on educational strategies, which might help to refine interventions in elementary science education."

— Juan Pascual-Leone

(About science activities)
"If we provide hands-on situations for children—for example, exploring density by testing out which objects sink and float or learning about electricity by experimenting with batteries, bulbs, and wires—they will reflect on the science phenomena that they observe and develop their own ideas about them."



Facsimile of a Police Car Built By Children

Paintings by 1st Grade Children After Trip to Zoo

(About constructivism)
"When we help children to develop their *own* ideas about the world around them... we are helping them develop *their* knowledge of the world. This is far more important than trying to pass on our own knowledge — a knowledge most young children will be unable to understand at this stage."

"Previous texts on the subject … neglected … grade levels one through three. This book … comprehensively deals with preschool/kindergarten *and* grades 1–3 and it contains over a hundred tested early childhood activities for mathematics and science."

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Constructivist Press
www.constructivistpress.com

$ 75.00

ISBN 13: 978-1-934478-36-3
ISBN 10: 1-934478-36-9
90000
9 781934 478363