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Chapter 8: Parametrization of Projectile Motion -- 8.1 Prior Research Findings -- 8.2 Theoretical Framework -- 8.2.1 Categories of Motion Studied in High School and Undergraduate Physics Courses -- 8.2.2 Why Parametric Equations? -- 8.2.3 Foundations of Constructivist Learning Theory -- 8.3 Methods -- 8.3.1 Study Description and the Research Question -- 8.3.2 The Participants -- 8.3.3 Lecture Component Sequencing -- 8.3.4 Topics Embedded within the Curriculum to Enhance the Treatment -- 8.4 General Lab Description -- 8.4.1 Lab Logistics -- 8.4.2 Gathering Data to Construct Positions Functions for a Projected Object -- 8.4.3 Constructing Representations of the Position Functions -- 8.4.4 Finding Velocities and Acceleration Functions -- 8.4.5 Verification Process -- 8.5 Treatment Evaluation -- 8.6 Summary and Conclusions -- References -- Chapter 9: Reimaging Lens Equation as a Dynamic Representation -- 9.1 Introduction -- 9.2 Prompts Used for the Instructional Unit Design -- 9.2.1 Mathematical Background -- 9.2.2 Lab Equipment -- 9.2.3 Conversion of Lens Equation into a Covariational Relation -- 9.2.4 Sketching and Scientifically Interpreting the Graph of the Lens Function -- 9.2.5 Formulating Magnification Function -- 9.2.6 Merging Mathematical and Experimental Representations into One Inquiry -- 9.3 Suggested Independent Student Work -- 9.4 Summary -- References -- Chapter 10: Embracing the Mole Understanding in a Covariate Relation -- 10.1 Introduction and Prior Research Findings -- 10.2 Theoretical Framework -- 10.2.1 Weaknesses of the Mole Understanding -- 10.2.2 Proportional Reasoning, Rates, and Ratios -- 10.3 Methods -- 10.4 The Lecture Component -- 10.4.1 The Mole as a Fundamental Unit of the Substance Amount -- 10.4.2 Converting the Number of Atoms to the Units of Moles.
10.4.3 Converting Mass of Substance to Moles -- 10.4.4 Converting Mass of a Substance to the Number of Atoms -- 10.5 Pretest Posttest Analysis -- 10.5.1 Analysis of the Pretest Results -- 10.5.2 Comparisons of the Pretest and Posttest Results -- 10.6 Summary and Conclusions -- References -- Chapter 11: Enabling Covariational Reasoning in Einstein's Formula for Photoelectric Effect -- 11.1 Prior Research -- 11.2 Theoretical Background -- 11.3 Embracing the PE into the Framework of Covariational Representation -- 11.3.1 Weaknesses of the Graph of KMAX Versus Photons' Frequency Presented in Physics Resources -- 11.3.2 Covariation of Photon's Energy and Frequency as a Linear Function -- 11.3.3 Electrons' Binding Energy as a Function of Photons Threshold Frequency -- 11.3.4 Maintaining a Minimum Number of Covariational Parameters During the Inquiry -- 11.4 Reassembling the PE Formula to Assure a Coherence of Representations -- 11.4.1 Graph Constructing -- 11.4.2 Finding Algebraic Representation of the Graph -- 11.4.3 Linking the Photons Threshold Frequency and the Work Function hfo = Wo -- 11.5 Summary and Conclusions -- References -- Chapter 12: Are Physics Formulas Aiding Covariational Reasoning? Students' Perspective -- 12.1 Introduction and Prior Research Findings -- 12.2 Theoretical Background and Methods -- 12.2.1 Foundations of Covariation Reasoning -- 12.2.2 Study Description, Participants, Research Questions, and Evaluation Instrument -- 12.3 Data Analysis -- 12.4 Summary and Conclusions -- 12.4.1 Traditional Formula Notation Does Not Aid Covariational Reasoning in Physics -- 12.4.2 Physics Depends on the Mathematical Rules and Notation -- References -- Chapter 13: Adaptivity of Mathematics Representations to Reason Scientifically Students' Perspective -- 13.1 Prior Research Findings.
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of the Treatment: How Did Covariational Reasoning Emerge? -- 13.3.2 Actions Taken to Exercise Covariation Model Using Laboratory -- 13.4 Data Analysis -- 13.5 Summary and Conclusions -- References -- Teaching Physics Using Mathematical Reasoning -- Research and Practice -- Index.

Sommario/riassunto

This book speaks about physics discoveries that intertwine mathematical reasoning, modeling, and scientific inquiry. It offers ways of bringing together the structural domain of mathematics and the content of physics in one coherent inquiry. Teaching and learning physics is challenging because students lack the skills to merge these learning paradigms. The purpose of this book is not only to improve access to the understanding of natural phenomena but also to inspire new ways of delivering and understanding the complex concepts of physics. To sustain physics education in college classrooms, authentic training that would help develop high school students' skills of transcending function modeling techniques to reason scientifically is needed and this book aspires to offer such training The book draws on current research in developing students' mathematical reasoning. It identifies areas for advancements and proposes a conceptual framework that is tested in several case studies designed using that framework. Modeling Newton's laws using limited case analysis, Modeling projectile motion using parametric equations and Enabling covariational reasoning in Einstein formula for the photoelectric effect represent some of these case studies. A wealth of conclusions that accompany these case studies, drawn from the realities of classroom teaching, is to help physics teachers and researchers adopt these ideas in practice.