



# Reconceptualizing STEM Education

The Central Role of Practices

**Edited by  
Richard A. Duschl and  
Amber S. Bismack**

TEACHING AND LEARNING IN SCIENCE SERIES

# Reconceptualizing Stem Education The Central Role Of Practices Teaching And Learning In Science Series

**Stephen J. Farenga, Salvatore G.  
Garofalo, Daniel Ness**



## **Reconceptualizing Stem Education The Central Role Of Practices Teaching And Learning In Science Series:**

*Reconceptualizing STEM Education* Richard A. Duschl, Amber S. Bismack, 2016-01-08 *Reconceptualizing STEM Education* explores and maps out research and development ideas and issues around five central practice themes Systems Thinking Model Based Reasoning Quantitative Reasoning Equity Epistemic and Ethical Outcomes and STEM Communication and Outreach These themes are aligned with the comprehensive agenda for the reform of science and engineering education set out by the 2015 PISA Framework the US Next Generation Science Standards and the US National Research Council's A Framework for K 12 Science Education The new practice focused agenda has implications for the redesign of preK 12 education for alignment of curriculum instruction assessment STEM teacher education and professional development postsecondary further and graduate studies and out of school informal education In each section experts set out powerful ideas followed by two eminent discussant responses that both respond to and provoke additional ideas from the lead papers In the associated website highly distinguished nationally recognized STEM education scholars and policymakers engage in deep conversations and considerations addressing core practices that guide STEM education *STEM Teacher Preparation and Practice for the 21st Century* Patrick M. Jenlink, 2022-09-01 *STEM Teacher Preparation and Practice for the 21st Century* Research based Insights introduces the reader to a collection of thoughtful research based works by authors that represent current thinking about the future of science technology engineering and mathematics or STEM as it known today as well as STEM education for a rapidly evolving global society and the preparation of STEM teachers to meet the educational needs of a changing educational landscape Each chapter focuses on STEM teaching and the preparation of teachers who will enter classrooms to instruct the next generation of students in STEM Research in the learning sciences focuses on the cognitive epistemological and socio cultural characteristics of scientific and engineering research communities in their efforts to improve Science Technology Engineering and Mathematics STEM education STEM education is a means to help individuals develop different strategies in order to solve interdisciplinary problems and gain skills and knowledge as they are engaged with STEM related activities through formal and informal learning programs Research also suggests that STEM may well stand as the new general education for the 21st century In much of the current discourse on teacher quality and preparation two essential points for consideration have emerged the strength of the relationship between teacher content knowledge and student achievement and the specific representations of knowledge that are most conducive to effective teaching Add to these two points one additional the nature of transforming a chaotic system of discreet preparation and clinical experiences into a coherent aligned and logical system of continuous and progressive development and support throughout a teacher's career These three points apply to STEM teacher preparation induction and professional learning as well as to teacher preparation induction and professional learning in general Importantly the contributing authors to this book have brought to the foreground research based insights concerning STEM teacher preparation Each chapter presents clear paths to

understanding and reimagining STEM teaching and the importance of STEM teacher preparation acknowledging the value of STEM literacy and the interdisciplinary nature of STEM teaching

**Handbook of Research on Learning and Instruction** Richard E. Mayer, Patricia A. Alexander, 2016-10-04 During the past 30 years researchers have made exciting progress in the science of learning i.e. how people learn and the science of instruction i.e. how to help people learn This second edition of the Handbook of Research on Learning and Instruction is intended to provide an overview of these research advances With chapters written by leading researchers from around the world this volume examines learning and instruction in a variety of learning environments including in classrooms and out of classrooms and with a variety of learners including K 16 students and adult learners Contributors to this volume demonstrate how and why educational practice should be guided by research evidence concerning what works in instruction The Handbook is written at a level that is appropriate for graduate students researchers and practitioners interested in an evidence based approach to learning and instruction The book is divided into two sections learning and instruction The learning section consists of chapters on how people learn in reading writing mathematics science history second language and physical education as well as how people acquire the knowledge and processes required for critical thinking studying self regulation and motivation The instruction section consists of chapters on effective instructional methods feedback examples questioning tutoring visualizations simulations inquiry discussion collaboration peer modeling and adaptive instruction Each chapter in this second edition of the Handbook has been thoroughly revised to integrate recent advances in the field of educational psychology Two chapters have been added to reflect advances in both helping students develop learning strategies and using technology to individualize instruction As with the first edition this updated volume showcases the best research being done on learning and instruction by traversing a broad array of academic domains learning constructs and instructional methods

**Quantitative Reasoning in Mathematics and Science Education** Gülseren Karagöz Akar, İsmail Özgür Zembat, Selahattin Arslan, Patrick W. Thompson, 2023-01-01 This book focuses on quantitative reasoning as an orienting framework to analyse learning teaching and curriculum in mathematics and science education Quantitative reasoning plays a vital role in learning concepts foundational to arithmetic algebra calculus geometry trigonometry and other ideas in STEM The book draws upon the importance of quantitative reasoning and its crucial role in education It particularly delves into quantitative reasoning related to the learning and teaching diverse mathematics and science concepts conceptual analysis of mathematical and scientific ideas and analysis of school mathematics K 16 curricula in different contexts We believe that it can be considered as a reference book to be used by researchers teacher educators curriculum developers and pre and in service teachers

*Socioscientific Issues-Based Instruction for Scientific Literacy Development* Powell, Wardell A., 2020-09-11 Socioscientific issues require individuals to use moral and ethical considerations to help in their evaluation of evidence and decision making entailing controversial scientific phenomena Such issues include genetic engineering and biotechnology Socioscientific issues

pedagogy has the potential to enhance students overall conceptual understanding of scientific phenomena that affect the daily lives of people across the globe Socioscientific Issues Based Instruction for Scientific Literacy Development is a critical scholarly publication that examines the development of a research based integrated socioscientific issues pedagogy for use in the K 12 system teacher education preparation and informal education centers The publication focuses on science education researchers and pre service and in service teachers abilities to design and implement meaningful learning opportunities for students to use rationalistic intuitive and emotive perspectives as they engage in information reasoning on scientific topics such as climate change and CRISPR that are of utmost importance Teachers in the K 12 system and informal education settings will be able to use this text to enhance scientific literacy among their students Instructors in teacher preparation programs will be able to use this research based text to improve pre service and in service teachers abilities to use socioscientific issues pedagogy to enhance scientific literacy among K 12 students Additionally audiences including researchers administrators academicians policymakers and students will find this book beneficial for their studies **STEM,**

**Robotics, Mobile Apps in Early Childhood and Primary Education** Stamatios Papadakis, Michail

Kalogiannakis, 2022-04-21 This book brings together a collection of work from around the world in order to consider effective STEM robotics mobile apps education from a range of perspectives It presents valuable perspectives both practical and theoretical that enrich the current STEM robotics mobile apps education agenda As such the book makes a substantial contribution to the literature and outlines the key challenges in research policy and practice for STEM education from early childhood through to the first school age education The audience for the book includes college students teachers of young children college and university faculty and professionals from fields other than education who are unified by their commitment to the care and education of young children **Science Curriculum for the Anthropocene, Volume 2**

Xavier Fazio, 2023-12-27 This edited volume the second of a two volume set presents science curriculum exemplars based on existing and future curriculum models Drawing upon complexity and systems theories this book will provide a framework for science curriculum that tackles and transforms the interrelated and socio ecological causes of our ecological crises The result is a refreshing and hopeful look at K 12 science curriculum in light of our current global trajectory in the twenty first century Chapter Future oriented Science Education Building Sustainability Competences An Approach to the European GreenComp Framework is available open access under a Creative Commons Attribution 4 0 International License via link [springer.com](https://www.springer.com) *Handbook of Formative Assessment in the Disciplines* Heidi L. Andrade, Randy E. Bennett, Gregory J.

Cizek, 2019-05-14 The Handbook of Formative Assessment in the Disciplines meaningfully addresses current developments in the field offering a unique and timely focus on domain dependency Building from an updated definition of formative assessment the book covers the integration of measurement principles into practice the operationalization of formative assessment within specific domains beyond generic strategies evolving research directions including student involvement

and self regulation and new approaches to the challenges of incorporating formative assessment training into pre service and in service educator training As supporters of large scale testing programs increasingly consider the potential of formative assessments to improve teaching and learning this handbook advances the subject through novel frameworks intersections of theory research and practice and attention to discernible disciplines Written for instructors graduate students researchers and policymakers each chapter provides expert perspectives on the procedures and evaluations that enable teachers to adapt teaching and learning in process toward student achievement

**Teaching the Sustainable Development Goals to Young Citizens (10-16 years)** Anne M. Dolan,2024-05-31 With the current climate and economic crises education for sustainability has never been more critical This timely and essential book encourages readers to rethink our current values systems and to interrogate common assumptions about our world Written for all educators with an interest in sustainability chapters address several possible future scenarios for our planet allowing readers to make more educated choices about sustainability and to transfer this knowledge to students within the classroom Each chapter focuses on a specific Sustainable Development Goal Beginning with a brief historical and theoretical introduction to contextualise the goal chapters then showcase the practical activities case studies and exemplars that teachers can adopt when teaching Topics explored include but are not limited to Poverty Renewable energy Climate change Peace and justice Human rights Access to education This book is an essential classroom resource for any teacher or student teacher wishing to promote the Sustainable Development Goals and to teach for a better and brighter future

*The Contribution of Mathematics to School STEM Education* Judy Anderson,Katie Makar,2024-06-10 This book presents contemporary STEM education research conducted by mathematics education researchers and their collaborators which highlights the important and pivotal role of mathematics in school STEM education It showcases evidence of the types of integrated curriculum approaches to STEM education which highlight mathematics as a key component and where mathematical concepts can be learnt through integrated tasks These examples challenge the idea that mathematics is just an application or servant to the other STEM subjects and highlight the contribution that mathematics can make to the understanding and practices of the other STEM subjects This book fills a void in the current research literature on the role of mathematics in STEM education provides evidence of the possibilities for designing integrated STEM curriculum and highlights current understandings of the role of mathematics in school STEM education For researchers it identifies and elaborates gaps to encourage further exploration in this field

Sensemaking in Elementary Science Elizabeth A. Davis,Carla Zembal-Saul,Sylvie M. Kademian,2019-10-16 Grounded in empirical research this book offers concrete pathways to direct attention towards elementary science teaching that privileges sensemaking rather than isolated activities and vocabulary Outlining a clear vision for this shift using research backed tools pedagogies and practices to support teacher learning and development this edited volume reveals how teachers can best engage in teaching that supports meaningful learning and understanding in elementary science classrooms Divided into three sections

this book demonstrates the skills knowledge bases and research driven practices necessary to make a fundamental shift towards a focus on students ideas and reasoning and covers topics such as An introduction to sensemaking in elementary science Positioning students at the center of sensemaking Planning and enacting investigation based science discussions Designing a practice based elementary teacher education program Reflections on science teacher education and professional development for reform based elementary science In line with current reform efforts including the Next Generation Science Standards NGSS Sensemaking in Elementary Science is the perfect resource for graduate students and researchers in science education elementary education teacher education and STEM education looking to explore effective practice approaches and development within the elementary science classroom *Supporting Self-Directed Learning in Science and Technology Beyond the School Years* Léonie J. Rennie,Susan M. Stocklmayer,John K. Gilbert,2018-12-21 While much has been written about science education from pre K through to postgraduate study interaction with science and technology does not stop when schooling ends Moving beyond scholarship on conventional education this book extends the research and provides an original in depth look at adult and lifelong learning in science and technology By identifying the knowledge and skills that individuals need to engage in self directed learning the book highlights how educators can best support adult learners beyond the years of formal schooling Through case studies and empirical analysis the authors offer a research based exploration of adults self directed learning and provide tools to support adults learning experiences in a wide range of environments while being inclusive of all educational backgrounds **International Handbook of Computer-Supported Collaborative Learning** Ulrike Cress,Carolyn Rosé,Alyssa Friend Wise,Jun Oshima,2021-10-08 CSCL has in the past 15 years and often in conjunction with Springer grown into a thriving and active community Yet lacking is a comprehensive CSCL handbook that displays the range of research being done in this area This handbook will provide an overview of the diverse aspects of the field allowing newcomers to develop a sense of the entirety of CSCL research and for existing community members to become more deeply aware of work outside their direct area The handbook will also serve as a ready reference for foundational concepts methods and approaches in the field The chapters are written in such a way that each of them can be used in a stand alone fashion while also serving as introductory readings in relevant study courses or in teacher education While some CSCL relevant topics are addressed in the International Handbook of the Learning Sciences and the International Handbook of Collaborative Learning these books do not aim to present an integrated and comprehensive view of CSCL The International Handbook of Computer Supported Collaborative Learning covers all relevant topics in CSCL particularly recent developments in the field such as the rise of computational approaches and learning analytics Teaching Biology in Schools Kostas Kampourakis,Michael Reiss,2018-05-23 An indispensable tool for biology teacher educators researchers graduate students and practising teachers this book presents up to date research addresses common misconceptions and discusses the pedagogical content knowledge necessary for effective teaching of key topics in biology

Chapters cover core subjects such as molecular biology genetics ecology and biotechnology and tackle broader issues that cut across topics such as learning environments worldviews and the nature of scientific inquiry and explanation Written by leading experts on their respective topics from a range of countries across the world this international book transcends national curricula and highlights global issues problems and trends in biology literacy *Critical Questions in STEM Education* Valarie L. Akerson, Gayle A. Buck, 2020-11-05 This edited volume offers a crosscutting view of STEM and is comprised of work by scholars in science technology engineering and mathematics education It offers a view of STEM from the disciplines that comprise it while adhering to the idea that STEM itself is an interdisciplinary treatment of all the associated disciplines in a meaningful way This book raises and answers questions regarding the meaning of STEM education and research This volume is divided into three sections the first one describes the nature of the component disciplines of STEM The next section presents work from leaders representing all STEM disciplines and deals with aspects such as K 12 and post secondary education The last section draws conclusions regarding the natures of the disciplines challenges and advantages of STEM education in terms of theoretical and practical implications The two final chapters compile arguments from the research chapters describing themes in research results and making recommendations for best STEM education practice and examining areas for future research in STEM education

**International Handbook of Research on STEAM Curriculum and Practice** Stephen J. Farenga, Salvatore G. Garofalo, Daniel Ness, 2025-10-24 This comprehensive handbook delves into curriculum praxis human development and cognition within the contexts of the STEAM disciplines science technology engineering arts architecture and mathematics Cutting edge research will help educators identify best practice techniques for developing students knowledge in STEAM subjects as well as capture contemporary social and political issues within the STEAM context Drawing on the work of over 50 international contributors this volume covers both emergent and established areas of research giving voice to newcomers to the field as well as perspectives from established experts These areas are divided into five sections on foundations content teaching and learning throughout the lifespan equity and enrichment and settings Each topic is considered in both its historical and current context with a focus on the interconnections between theory and practice This book offers a first of its kind overview of STEAM curriculum development which will be especially useful to educational practitioners and researchers of STEAM subjects as well as teacher educators overseeing STEAM education This resource will also be useful for K 12 school and institutional libraries as reference material and for curriculum specialists and administrators seeking to identify methods of best educational practices within STEAM

STEM Education in Primary Classrooms Angela Fitzgerald, Carole Haeusler, Linda Pfeiffer, 2020-03-12 If you were to peer into a primary school classroom somewhere across Australia and New Zealand you would be forgiven for thinking that science technology engineering and mathematics STEM education is synonymous with coding and digital technologies However while these aspects are important technology alone does not reflect the broad learning opportunities afforded by



STEM In countering this narrow approach STEM Education in Primary Classrooms offers a platform for research that innovates excites and challenges the status quo It provides educators with innovative and up to date research into how to meaningfully and authentically embed STEM into existing classroom practices It incorporates accurate explanations of STEM as an integrated approach to solving real world problems including social issues along with case studies and stories to bring practice to life in evidence informed ways This book showcases the impact of a broader approach to STEM in the primary classroom through Australian based and New Zealand based research that will challenge current teaching practices Thus this book will be of interest to pre and in service primary school teachers along with researchers and postgraduate students in the STEM education field

**Cross-disciplinary STEM Learning for Asian Primary Students** Winnie Wing Mui So,Zhi Hong Wan,Tian Luo,2023-11-27 Given the importance of student learning in the various types and integration of STEM education this book provides a landscape of cross disciplinary STEM learning in Asian primary schools and a systematic overview of design practices and outcomes of STEM learning implementation Science Technology Engineering and Mathematics STEM has continued to attract attention worldwide and there have been calls for the promotion of STEM education in primary schools to nurture students to meet the needs of societies in terms of innovation and technology development Since STEM is complex in nature and is related to various disciplines the effort of a single discipline may not be as effective as cross disciplinary efforts This edited volume involving an Asian team of authors examines how cross disciplinary STEM learning can be designed for students to achieve viable outcomes and what opportunities and challenges have been offered to the next generation to equip them with the necessary skills knowledge and ways of thinking as well as attitudes and values for lifelong learning A resourceful text for students researchers and practitioners interested in the rich development of STEM education and practical methods for a variety of learning approaches from elementary to secondary education has been provided

**EDUCAÇÃO EM ANÁLISE: Pesquisas, Saberes e Práticas** ,2025-04-15 Esta coletânea reúne reflexões e práticas que expressam a educação sob diversas perspectivas teóricas metodológicas e sociais oferecendo um panorama abrangente e enriquecedor para os interessados em desvendar os múltiplos caminhos do processo educativo Com foco nas dinâmicas contemporâneas e nos desafios permanentes da educação a obra destaca temas fundamentais para educadores pesquisadores e todos os que atuam na construção de uma educação mais acessível e inclusiva Ao integrar investigações acadêmicas e experiências concretas os capítulos abordam desde as teorias clássicas e suas aplicações práticas até as questões emergentes como neurociência tecnologias educacionais e metodologias inovadoras A coletânea também promove um olhar sensível sobre contextos específicos ampliando o debate sobre a relevância da interdisciplinaridade e das políticas educativas Em síntese esta obra fomenta a inovação o diálogo e o avanço do conhecimento para qualificar as práticas educativas e enriquecer os contextos de aprendizagem

**Re-Conceptualizing Safe Spaces** Kate Winter,Andrea Bramberger,2021-10-25 This book broadens the idea of a safe space that is traditionally discussed in feminist studies to

include gendered identities intersecting with class race ethnicity sexual orientation and ability within multiple aspects of education This collection showcases work supporting access to education of persistently marginalized individuals

## Decoding **Reconceptualizing Stem Education The Central Role Of Practices Teaching And Learning In Science Series**: Revealing the Captivating Potential of Verbal Expression

In an era characterized by interconnectedness and an insatiable thirst for knowledge, the captivating potential of verbal expression has emerged as a formidable force. Its capability to evoke sentiments, stimulate introspection, and incite profound transformations is genuinely awe-inspiring. Within the pages of "**Reconceptualizing Stem Education The Central Role Of Practices Teaching And Learning In Science Series**," a mesmerizing literary creation penned with a celebrated wordsmith, readers embark on an enlightening odyssey, unraveling the intricate significance of language and its enduring effect on our lives. In this appraisal, we shall explore the book's central themes, evaluate its distinctive writing style, and gauge its pervasive influence on the hearts and minds of its readership.

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