

Teaching Science and Investigating Environmental Issues with Geospatial Technology

James MaKinster • Nancy Trautmann
Michael Barnett
Editors

Teaching Science and Investigating Environmental Issues with Geospatial Technology

Designing Effective Professional
Development for Teachers

 Springer

Editors

James MaKinster
Hobart & William Smith Colleges
Geneva, NY, USA

Nancy Trautmann
Cornell Laboratory of Ornithology
Ithaca, NY, USA

Michael Barnett
Lynch School of Education
Boston College
Chestnut Hill, MA, USA

ISBN 978-90-481-3930-9 ISBN 978-90-481-3931-6 (eBook)
DOI 10.1007/978-90-481-3931-6
Springer Dordrecht Heidelberg New York London

Library of Congress Control Number: 2013953496

© Springer Science+Business Media B.V. 2014

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed. Exempted from this legal reservation are brief excerpts in connection with reviews or scholarly analysis or material supplied specifically for the purpose of being entered and executed on a computer system, for exclusive use by the purchaser of the work. Duplication of this publication or parts thereof is permitted only under the provisions of the Copyright Law of the Publisher's location, in its current version, and permission for use must always be obtained from Springer. Permissions for use may be obtained through RightsLink at the Copyright Clearance Center. Violations are liable to prosecution under the respective Copyright Law.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

While the advice and information in this book are believed to be true and accurate at the date of publication, neither the authors nor the editors nor the publisher can accept any legal responsibility for any errors or omissions that may be made. The publisher makes no warranty, express or implied, with respect to the material contained herein.

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Foreword

“If we teach today’s students as we taught yesterday, we rob them of tomorrow.”

– John Dewey

For over two decades, researchers, trainers, and curriculum developers have designed, conducted, and evaluated teacher professional development supporting the use of geospatial technologies in education. These trailblazers pushed toward better practice in science teaching, using methods and principles that extended inquiry in personalized and authentic ways for students. That path, while sometimes bumpy and always shifting, shows signs of success emerging in classrooms, laboratories, the field, and beyond. This volume celebrates the hard work of many and the notable success of a few.

Science education is at a watershed moment, squarely in the public spotlight with the recent release of The Next Generation Science Standards,¹ and calls for increased STEM (Science, Technology, Engineering, and Math) education from the White House to learners. Over the past decade, STEM job growth has been three times higher than non-STEM² and annual earnings are typically 11 % higher.² To better prepare for twenty-first-century careers and college, all students must better leverage data analysis technologies to extend “science and engineering practices” as envisioned by the new standards, while fostering critical thinking and great decision-making. Effective professional development is the first step in this process.

In this landscape, geospatial technologies – geographic information systems (GIS), global positioning systems (GPS), remote sensing (RS), and digital globes – provide limitless STEM-rich opportunities; they allow students to analyze climate change, design cities, inventory geologic samples, plan ecological models, catalog contents of an archaeological site, and endless choices. They affect all sectors of society and every arena of employment, from local to global and across all aspects of business and government. The geospatial technology sector is expanding, with estimates of global revenue as high as \$270 billion annually³ and nearly 10 % growth in the identified US geospatial workforce through 2020.⁴ The future is

bright! Students educated using geospatial technologies are now estimated to have at least a 3 % higher starting salary on average.³ Students, as future geospatial professionals or as spatially literate citizens, must be able to effectively understand and analyze location-based information to succeed in the world today, but especially tomorrow.

Across society, technology is evolving at a blistering and accelerating pace, and this evolution is changing education. Mobile devices, cloud computing, and broadband Internet access are changing the way we teach and learn. Today, 75 % of teens in the USA carry a mobile phone.⁵ The move to cloud computing means fewer software installation issues, more personalized interfaces, and expanded collaboration for students. Cloud computing is the architecture that supports the current vision of “Geography as a platform” with over 50 % of Europeans using cloud computing to access geospatial and location analytics services.³ These consumer technologies are blending with and reshaping geospatial technology, creating entirely new technical niches and knowledge in education and across society.

Despite our rapidly changing world, we still contend with some of the same core professional development challenges faced years ago. The grand challenge might be summarized as, “How do we design and implement effective professional development that leads to a lasting, positive change in tomorrow’s spatially enabled science teacher practice?” There are no easy answers, but there is promise.

This collection is part of that promise. It describes some practices and approaches in science education that have worked, and some that have not, yielding critical recommendations for sighting our way forward. While some conditions have changed and technologies have evolved even since these studies took place, their lessons retain valuable meaning. For those who design or implement professional development with advanced technology, this volume will greatly inform your professional practice – a critical first step toward enhancing teaching and learning.

1. Achieve Inc. (2013). Next Generation Science Standards. Retrieved from: <http://www.nextgenscience.org/>.
2. Thomasian, J. (2011). Building a science, technology, engineering, and math education agenda. National Governor’s Association. Retrieved from: <http://www.nga.org/files/live/sites/NGA/files/pdf/1112STEMGUIDE.PDF>.
3. Oxera Consulting. (2013). What is the economic impact of geo services? Retrieved from: <http://www.oxera.com/Publications/Reports/2013/What-is-the-economic-impact-of-Geo-services-.aspx>.
4. O*Net Online. (2013). Summary report for geospatial information scientists and technologists. Retrieved from: <http://www.onetonline.org/link/summary/15-1199.04>.
5. Madden, M. (2011). Teens, social network sites & mobile phones: What the research is telling us. Pew Research Center’s Internet & American Life Project. Retrieved from: http://pewinternet.org/~media/Files/Presentations/2011/Dec/Teens%20SNS%20and%20Mobile%20Phones%20presentation%20pdf%20-%20COSN_120511.pdf.

Preface

Geospatial technologies provide unique ways in which to view, explore, and understand our world. Over the past 20 years, GIS, GPS, and other geospatial tools have moved from the hands of geographers and scientists into the realm of everyday life. The scope and reach of geospatial technologies have grown immensely through the development of user-friendly software such as virtual globes and web-based GIS. At the same time, the widespread adoption of tablets and smartphones has greatly simplified location-based mapping and brought it into the public sphere.

This book is situated within the time frame of this sweeping transition in the ways in which we view and relate to our environment. The projects represented here were undertaken because their leaders recognized tremendous opportunity in using geospatial tools to help students and teachers better understand the world around them and because funding agencies recognized the need for students to become better versed in technological applications and related careers.

Our goal is to share the challenges, successes, and lessons learned across a broad range of projects designed to help teachers integrate geospatial technologies into their science teaching. We aim to inspire continuing innovation in project implementation paired with research into best practices in teacher professional development in support of teaching science with geospatial technologies.

The projects represented in this book were supported through grants from the National Science Foundation, NASA, Environmental Protection Agency, Toyota USA Foundation, Hewlett Packard Foundation, National Geographic Education Foundation, and other agencies. We extend thanks to the directors, program officers, and staff of these agencies who strive to improve K-12 education through providing essential support for educational innovation, collaboration, and the translation of contemporary science into learning experiences for students.

We greatly appreciate the work of everyone at Springer who helped to bring this volume to fruition.

Most of all, we wish to thank the teachers and students who we have served and worked with over the years. It is through their eyes that our work has meaning and they have taught us so much. We are eternally grateful.

Geneva, USA

James MaKinster
Nancy Trautmann
Michael Barnett

Contents

1 Introduction	1
James MaKinster, Nancy Trautmann, and Michael Barnett	

Part I Designing Effective Professional Development Projects

2 Participatory Professional Development: Geospatially Enhanced Urban Ecological Field Studies	13
Michael Barnett, Meredith Houle, Sheron L. Mark, Daphne Minner, Linda Hirsch, Eric Strauss, Lindsey Cotter-Hayes, and Beth Hufnagel	
3 Field-Based Research Partnerships: Teachers, Students, and Scientists Investigate the Geologic History of Eastern Montana Using Geospatial Technologies	35
Heather Almquist, Lisa Blank, Jeffrey W. Crews, George Stanley, and Marc Hendrix	
4 Meeting Teachers Where They Are and Helping Them Achieve Their Geospatial Goals	51
Nancy Trautmann and James MaKinster	
5 Spatial Sci: Forwarding Geospatial Technology Innovations in the Classroom	65
Lisa M. Blank, Jeffrey W. Crews, and Randy Knuth	
6 Eyes in the Sky: Facilitating Classroom Research Using Geospatial Technology	83
Carla McAuliffe and Jeff Lockwood	
7 CoastLines: Commitment, Comfort, Competence, Empowerment, and Relevance in Professional Development	99
Steven D. Moore, Don Haviland, Allison Whitmer, and Jenny Brady	

8	The Inquiring with GIS (iGIS) Project: Helping Teachers Create and Lead Local GIS-Based Investigations	119
	Cathlyn D. Styliniski and Cassie Doty	
9	Communities for Rural Education, Stewardship, and Technology (CREST): A Rural Model for Teacher Professional Development.....	139
	Shey Conover, Ruth Kermish-Allen, and Robert Snyder	
10	Curriculum-Aligned Professional Development for Geospatial Education	153
	Beth Kubitskey, Barry Fishman, Heather Johnson, Kirsten Mawyer, and Daniel Edelson	
11	Impact of Science Teacher Professional Development Through Geospatial Technologies: A 5-Step Program of Support	173
	Rita A. Hagevik, Harriett S. Stubbs Emeritus, Christiane Gioppo, and Diane C. Whitaker	
Part II Designing and Implementing Innovative and Effective Curricular Materials		
12	The Data Sets and Inquiry in Geoscience Education Project: Model Curricula for Teacher Capacity Building in Scientific Inquiry Tasks with Geospatial Data.....	193
	Daniel R. Zalles and Amy Pallant	
13	Designing Google Earth Activities for Learning Earth and Environmental Science.....	213
	Alec M. Bodzin, David Anastasio, and Violet Kulo	
14	Designing Geospatial Exploration Activities to Build Hydrology Understanding in Middle School Students	233
	Louise Yarnall, Philip Vahey, and Karen Swan	
15	Lonely Trailblazers: Examining the Early Implementation of Geospatial Technologies in Science Classrooms	251
	Thomas R. Baker and Joseph J. Kerski	
16	Understanding the Use of Geospatial Technologies to Teach Science: TPACK as a Lens for Effective Teaching	269
	James MaKinster and Nancy Trautmann	
17	Moving Out of Flatland: Toward Effective Practice in Geospatial Inquiry	287
	Bob Coulter	

**18 What Happens After the Professional Development:
Case Studies on Implementing GIS in the Classroom..... 303**
Robert Kolvoord, Michael Charles, and Steve Purcell

Part III Final Chapters

**19 The Nature and Design of Professional Development
for Using Geospatial Technologies to Teach Science..... 323**
James MaKinster and Nancy Trautmann

**20 The Nature of Teacher Knowledge Necessary
for the Effective Use of Geospatial Technologies
to Teach Science 333**
James MaKinster and Nancy Trautmann