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

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-STEM[2] 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 annually[3] 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.

Geneva, USA Thomas R. Baker
ESRI

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