Inspiring STEM Minds

Biographies and Activities for Elementary Classrooms

Aaron D. Isabelle and Nataly Z. Valle

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PREFACE

Let us start by telling a story – a personal story about mathematics. Once upon a time there was a little girl who didn't believe she was good at mathematics. In fact, although she was a good student, her lack of confidence and quiet demeanor often made her feel invisible in the classroom. One day in pre-algebra class, she was introduced to inequalities and systems of equations. She learned several ways to manipulate them in order to, as her teacher put it, "solve for x." Although it would take decades for her to understand what the unknown actually was referring to in an equation, she was entranced with the mathematical process itself, seeing it as a game that had many strategies and only a few key rules. Unfortunately, the game became more difficult for her as the rules and the process became more rigid as the lessons progressed. Then, one day the teacher told her a story about Albert Einstein. When he was working on a problem, Einstein would often take long walks outside and he especially liked to play his violin during the times when the solution proved most difficult. In fact, it was during one of these intense music/walking sessions that Einstein discovered the General Theory of Relativity. Coincidentally, the girl also played the violin, and who doesn't like taking a walk to clear one's head? Mathematics became a game again, and the girl soon found out that not only did she enjoy this game, but that she was getting pretty good at it, too.

While it is clear who the little girl is, it may not be clear to the reader yet why this story is important for this book. Stories compel us in many ways, evoking powerful emotions, stirring us to action, and causing us to make connections in our lives we may not otherwise do. Stories are important educational tools, as well, but often are not pedagogically theorized or explicitly drawn out in lesson plans as they ought to be.

This book began as an assignment given to our students for the purpose of getting them to understand how to immerse elementary age children into the wondrous and exciting world of Science, Technology, Engineering, and Mathematics (STEM). Although we did not have our students write a story (i.e., narrative) about a person in the STEM disciplines, we did have them craft biographies of various individuals who they were interested in and who they thought elementary children would also find intriguing. In other words, we had our students focus on key excerpts in the "stories of the lives" of individuals who either previously or currently work in one of the STEM fields. Our ultimate goal was to help our students realize the human side of STEM.

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CHAPTER 1

INTRODUCTION

STEM POLICY

STEM education can be described as a group of wide scale education reform policies that aim to target the teaching and learning of four main disciplines: science, technology, engineering, and mathematics (STEM). The education of mathematics, science, engineering, and technology is arguably the United States' most discussed educational topic of the 21st century (Sanders, 2010). Generally, the STEM initiatives have two main interconnecting objectives. At the national level, the STEM initiatives strive to increase the pool of qualified workers that the nation supposedly needs in order to stay economically competitive in the global marketplace. At the individual citizen level, the STEM initiatives aim to produce citizens who are able to procure financially secure employment in an ever-increasing technological world (Bybee, 2010; Brown, Brown, Reardon & Merrill, 2011). The initiatives span federal, state, local, and private levels targeting various diverse groups using specific strategies to achieve STEM related goals.

At the United States federal level, initiatives and policies such as "Educate to Innovate," and "America Competes Act" focus on accomplishing STEM objectives by: (1) Creating stronger partnerships between the business world and education; (2) Inspiring students to like and continue learning STEM content knowledge; (3) Giving more federal money to specific state-led STEM programs; (4) Training better teachers to teach STEM at K-12 levels; and (5) Increasing access to high quality STEM education to underprivileged minority groups above from. These objectives illustrate the key recommendations outlined in the highly influential policy document titled, "Rising above the Gathering Storm," which warned American education policy makers and stakeholders that if the United States did not increase its education of the critical 21st century knowledge, particularly in technology, engineering, and innovation, it would lose its position as a global leader. Indeed, the United States is not alone in its concern for maintaining global influence. Many countries have increased their educational efforts to promote STEM education, as well as research on the teaching and learning of STEM (see for instance *The International Journal of STEM Education*).

Commonly in education, the four disciplines that make up STEM are viewed as separate domains of knowledge, tied together mainly for the role they play in the job market of the 21st century global world. However, how best to facilitate learning in these content areas remains disputed and fragmented depending on what age group is being discussed. Initially, STEM reforms targeted higher education and career readiness programs in an effort to get talented individuals to enter STEM fields. As STEM education became better known, policy makers realized that in order to obtain more STEM qualified workers, they needed to concentrate on K-12 education. Most recently, attention is being paid to elementary education (K-6) since that is where the initial interest in STEM fields is thought to occur, not to mention the time in which students learn important knowledge that can help aid understanding of these abstract subject areas as children progress through the grade spans.

Private and public organizations such as the National Council of Teachers of Mathematics (NCTM) and the *Partnership of 21st Century Skills* (21st Century Community Learning Centers, 2003) advocate for the importance of earlier exposure to STEM fields, particularly to promote creative and problem-solving abilities in young people, believed to be so integral to future employment and democratic citizenship. At the elementary level, researchers advocate that STEM education ought to involve interactive problem solving, inquiry-based activities that inspire young learners (Dejarnette, 2010). This recommendation for meaningful hands-on problem solving and inquiry-based learning often also includes fostering creative capacity.

The main objective for STEM education during elementary grades is twofold; foremost, policy makers advocate for garnering interest in STEM subjects and careers, explaining that early years of education are pivotal for enticing students to get excited about mathematics, science, technology, and engineering. Certainly, another aspect is to ensure students gain a strong proficiency in mathematics and science, and problem solving, which will serve them well as they advance in their studies.

THE HISTORY OF STEM IN ELEMENTARY CLASSROOMS

Science and mathematics in elementary classrooms are typically characterized by asking students to learn something in a matter of days that could have taken hundreds or thousands of years to understand. Too often teachers compress, as well as simplify, the time and energy that was spent by various individuals

in investigating how or why something works. Unfortunately, due to the time constraints and/or the demands of high-stakes testing, teachers frequently disregard the human effort that it took to really understand something. From this perspective, it should make sense that science and mathematics are often seen as difficult, complex, and confusing subjects. Teachers who are truly dedicated to incorporating all of the STEM disciplines into their classrooms must remember that one of the most exciting aspects of teaching these subjects is conveying *how* a theory, law, or principle was developed and then engaging children in the process of discovery for themselves. The history of science and mathematics is one of the best resources for this. More precisely, given the charge of the *Next Generation Science Standards (NGSS*) and the *Common Core State Standards (CCSS) in Mathematics*, we should refer to this exemplary resource in its entirety as "The History of STEM."

STEM education is most effective when a child is taught to think and act as a scientist, mathematician, inventor, or engineer. Use of STEM biographies not only reveals appropriate science, mathematics, and engineering behaviors and practices, but also "provides a background and alternative perspective of previous work" (Zimmer, 2015). History and biographies in the STEM disciplines can enable teachers to examine "the story" behind a scientific or mathematical principle. Teachers, along with the children, can collaboratively explore how a particular scientist, mathematician, inventor, or engineer arrived at his/her discovery. "Many students have not had the opportunity to have history and biography integrated into science/math education; they suffer because their understanding of these topics has been limited" (Zimmer, 2015). Hopefully, with the emergence of new learning standards, schools will begin to fully understand the importance of including the historical context of STEM principles in the elementary curriculum.

Biographies in STEM have immense potential in the elementary classroom because they show that research and exploration are continually on-going; that is, one question arises from another question (Hagen, 2000). At the same time, in attempting to convey a discovery using the history of STEM, it is very easy to get lost in historical details that may not be particularly meaningful to children. When using biographies as a learning tool in the elementary classroom, it is extremely important to focus on key details that are both interesting and relevant to children's lives. In addition, it is critical to utilize a "global approach" when researching and implementing STEM biographies (rather than simply a Western account of the history of STEM) to more accurately reflect the diverse backgrounds of children in modern elementary classrooms.