Journal of Elementary Science Education, Vol. 21, No. 3 (Summer 2009), pp. 33-46.

Role-Playing in Science Education: An Effective Strategy for Developing Multiple Perspectives

Elaine V. Howes, University of South Florida
Bárbara C. Cruz, University of South Florida

Role-Playing in the College Classroom

Five young women are up at the front of the college classroom, and their 25 classmates are attentive to the goings on. One steps behind the lecture podium as the others take their spots in chairs set in a row. The woman behind the podium announces that this is "The Oprah Show," and then proceeds to initiate a conversation with her scientist guests. The participants are self-possessed and serious, picking up on each other's comments to describe their unique lives and perspectives. They are in agreement in their responses to the question of today's show, "Who does science?," although their expertise ranges from primatology to cancer research, robotics, and environmental activism. Their unanimous conclusion: "Anyone who has a question that she is passionate about can be a scientist."

As the real-life vignette above illustrates, role-playing can be an engaging and creative strategy to use in the college classroom. Using official accounts, personal narratives, and diaries to recreate a particular time period, event, or personality, the instructional strategy alternately referred to as role-playing, dramatic improvisation, or first-person characterization can be an effective way to have students discover and share multiple perspectives.

While much of the evidence for the efficacy of role-playing is at the K-12 level (Arce, 2006; Beck & Czerniak, 2005; Borbely, Graber, Nichols, Brooks-Gunn, & Botvin, 2005; Fennessey, 2000; McDaniel, 2000; Wilcox & Sterling, 2006), the use of role-playing in higher education is being increasingly documented by a number of scholars (Blatner, 2006; Doron, 2007; Lebaron & Miller, 2005; Shearer & Davidhizar, 2003). Business schools have used case studies and role-playing for years (Brown, Li, Sargent, & Tasa, 2003; Mitri & Cole, 2007; Muncy, 2006). Counseling and psychology often use role-playing to afford future professionals with real-life scenarios (Dollarhide, Smith, & Lemberger, 2007; Kocarek & Pelling, 2003; Poorman, 2002). The social sciences, too, are disciplines for which role-playing seems ideally suited (Alden, 2005; Maddrell, 2007; McDaniel, 2000; Van Assendelft, 2006; Woodward, 2003).

Educators in the natural sciences have recently begun to use role-playing as an instructional strategy. Jackson and Walters (2000) report success using role-playing in analytical chemistry, encouraging a deeper understanding of content and the development of communication and collaborative skills. Fox and Loope (2007) describe a strategy for exploring ecological and social issues by using the case study of invasive species in Hawaii in a role-playing exercise that requires students to integrate information from biological, geographical, social, and political

science sources. Smythe and Higgins (2007) describe their use of role-playing in an environmental chemistry lecture course; they reported a great increase in student participation, an understanding of political implications, and the development of speaking and debating skills.

Preservice science teacher education would seem to be a natural "fit" with role-playing pedagogy. While little has been written in this regard, Metz (2005) describes an innovative approach used with prospective science teachers where each student was assigned a role that correlated with a museum exhibit. This exercise served as a mechanism for science teaching and resulted in a more authentic learning experience because students experienced real-life activities in historical context. Studying a commonly used strategy in science education, Palmer (2006) found that preservice teachers' self-efficacy increased when they took on the roles of children as their professor modeled science teaching. These experiences by teacher educators point to possibilities for role-playing strategies in science methods courses, specifically to help students revise their views of science and scientists.

Nearly 40 years ago, Hughes (1971) noted that prospective science teachers' common vision of a scientist was "a 'brain' that engages in dull, monotonous, time-consuming work and has no time for . . . a family or other earthly pleasures" (p. 114). Unfortunately, visions of scientists among children and preservice teachers have changed little in the ensuing years (Buck, Leslie-Pelecky, & Kirby, 2002; McAdam, 1990; Rahm, 2007). Representing scientists as exceptionally intelligent, antisocial, White men working in laboratories, these persistent stereotypes alienate many students (Finson, 2000) and serve to mask the genuine diversity of historical and contemporary scientists. Thus, we believe that learning how to teach science involves critiquing these stereotypes and developing realistic visions of actual scientists. This article discusses a strategy created to address the ongoing educational concern of students' stereotypical visions of scientists. What follows is a description of a role-playing project designed to inspire education students to rethink their stereotypes of scientists and replace them with real-life examples to carry into their science teaching.

Role-Playing in Science Education: Studying Students' Learning about "What Is a Scientist?"

Introducing the Role-Playing Assignment

On the first day of the preservice elementary science methods class under discussion in this article, students conducted a version of the oft-used "Draw a Scientist" activity (Finson, 2002). As best as they could, students drew unedited images that came to mind upon hearing the word *scientist*. This activity revealed the students' own stereotypical visions and provided material for discussion of these stereotypes and their implications for children's engagement with science. An overwhelming majority of students drew male scientists; most were in laboratories accompanied with test tubes, Bunsen burners, and periodic tables, wearing lab coats and unfashionable hairstyles. After analyzing the messages implied by these stereotypical images, students brainstormed a list of scientists. When the usual suspects from Galileo to James Watson and Piaget (these being education majors) were named and listed on the board, the "token" scientists Marie Curie and George Washington Carver joined their ranks. The students were then asked to push themselves harder and to look at the list on the board and note "How

many men?," "How many women?," "How many White scientists?," and "How many African-American, Latino, Asian-American, or international scientists?" The list expanded as students named female scientists such as Jane Goodall and Rachel Carson, African-American inventors such as Louis Latimer and Madam C. J. Walker, populizers of science such as Jeff Corwin and Bill Nye, and even cooking show hosts like Julia Child and Alton Brown. This brainstorming serves as an entry into the "Becoming a Scientist" role-playing assignment as students themselves begin to ask, "Why did we learn about such a limited group of scientists in school? How can we help *our* students learn more and, at the same time, help them see that they can become scientists, too?"

Learning from Students' Work

Student Population

This study draws upon student work created through the role-playing activity described in detail below, conducted during an elementary methods course taught at a large public university in the southeast United States. The students were all juniors and seniors at different points in the teacher education program—some had just begun, some were completing their final internship, and others were somewhere in between. This methods course is taken when it fits into the students' schedules and, thus, is not an integral part of the elementary education program itself but, rather, is taught through a different department as a "service course." This section of 30 students was representative of the make-up of the university population in that many students were first-generation college attendees, and most were local residents, although some were recent migrants from northern states. The majority of the students were female.

Keeping Track of Students' Thinking

During a discussion on the first day of class inspired by their drawings of scientists, students' ideas were recorded on the board and copied down for future reference. While not identified with individual students, these data served as a general measure of their incoming beliefs about the kinds of people who do science. The class's description of a stereotypical scientist was a White man with unfashionable hair and glasses, wearing a white coat, who worked alone in a laboratory with explosive chemicals, test tubes, lab animals, and a periodic table.

We also used the students' completed "Biography of a Scientist: What Is Science?" tables (see Figure 1); these indicated which scientists students chose to study for this assignment and provided student comments to enrich our understanding of their visions of scientists. Finally, students wrote about their experiences with this activity, responding to the questions, "What did you learn from this activity?" and "What would you want your own students to learn from this activity?" Notes on students' group presentations form the final data source. The quotes and descriptions in this article are drawn from the students' completed tables, their written reflections, and their presentations and, thus, demonstrate students' own interpretations of their learning through the activity.

Figure 1. Biography of a Scientist—What Is Science?

Describing word or phrase about _____ (your scientist)	Evidence to support this assertion

According to _____, science is _____

_____.

Note: This table is adopted from one created by Kathleen J. Roth for her methods course at Michigan State University.

Collaborative Teacher Research

Our analysis is based in teacher-research methodology which argues that teachers can learn from their own teaching by viewing their work as a site for researching students' thinking and learning (Capobianco, 2007; Dinkelman, 2003; Feldman & Minstrell, 2000; van Zee & Roberts, 2001). This study examines one case of a reform-oriented science activity to inform ourselves and others concerning its efficacy as recommended by Roth (2007). To systematically examine our data for this teacher research study, students' work was transcribed by the first author (i.e., the course professor); she initially noted and categorized strands in students' thinking. These were approved, modified, or discarded by the second author (i.e., a social science teacher educator) and then revised again by the first author. This collaborative, reiterative analysis and writing reflects a constant comparison methodology (Glaser & Strauss, 1967) in which we name categories and return to the data to reject, change, or refine those categories. We were better able to critique each others' thinking because this analysis was conducted by two authors based in different disciplinary perspectives. This aspect of the study was particularly useful in terms of questioning the science educator's assumptions and, thus, requiring a deeper examination of the data. In addition, this collaboration between a science and a social science educator helped us to envision ways in which this assignment could be usefully implemented as an interdisciplinary elementary classroom activity.

The "Becoming a Scientist" Role-Playing Assignment

Preparing for the Seminar

The role-playing assignment examined in this study begins as an individual research assignment in which students are instructed to learn about a scientist of their choice who breaks the stereotypical mold; scientists from underrepresented groups are especially encouraged. In researching the scientists' lives and work, students explore library holdings, Internet resources, and biographies written for adults or children. Students are provided with a simple chart to guide them in the process (see Figure 1). The chart helps craft succinct, clear descriptions and clarify the question "What is science?" It also helps students develop and use their scientist's "voice."

The Seminar

On the day that the assignment is due, we hold a "seminar" in which the professor asks the students to imagine that they are scientists from all over the world and from throughout time who have been called together to help Gopher Tortoise Elementary School teachers think about science teaching. This "Becoming a Scientist Seminar," during which students role-play the scientists they have researched, is always lively and varies from class to class. Some students come dressed in makeshift costumes and some bring props, but most come simply as they are. The professor serves as the host and facilitator of the seminar, herself adopting a nonstereotypical scientist persona (e.g., Ynés Mexía) (see Anema, 2005).

To begin the seminar, students (in the roles of their varied scientists) participate in a group exercise in which they create a presentation for the fictitious Gopher

Tortoise Elementary School. Thus, although their research is completed individually, the results are shared with the entire class, serving as an exciting example of peer teaching. Pre-selected by the professor to ensure a heterogeneous mix of students, each group is charged with providing counsel to the teachers and administrators of Gopher Tortoise Elementary School on creating instruction that represents the best approaches to teaching science, from the team members' perspectives as successful scientists. Since they are role-playing, students are challenged to portray what they think their scientist would say, not what they themselves would say.

In their groups, the students/scientists are asked to first briefly describe their lives and work as scientists and to respond to the question, "What is science?" Next, they are to come to consensus on the three questions below:

1. How do you want children to define science?
2. What kinds of people do you want children to see as doing science and being scientists? Share your real-life examples here!
3. What suggestions do you have for teachers and administrators who want to help kids develop these ways of thinking about and doing science?

Finally, the groups prepare presentations for the faculty of Gopher Elementary, which the scientists are encouraged to make as engaging and powerful as possible, keeping in mind that their "audience" is one of busy and skeptical elementary school practitioners. The seminar facilitator makes available material for visual aids and encourages dramatic and creative presentation styles. Some students choose electronic media; for instance, students in their roles as Nicola Tesla, Cynthia Breazeal, Maria Montessori, Jane Goodall, and Ivan Pavlov created a *PowerPoint* presentation where they described the scientists' work, responded to the required questions, and added a song that they had found online describing the "scientific method." Another group responded to the questions in the context of an "Oprah" simulation, via which they were interviewed about their work and their beliefs about science. Skits based in television talk or game shows are very popular, and the students who participate in them do a convincing and in-depth job of representing their scientists. Although most students elect to use visual aids made from newsprint or poster board and more straightforwardly present their findings, the more adventurous presentations add to what one student called the "entertainment" value of the activity.

All groups indicated in their presentations that they wanted teachers to show children that "science is for everyone." They regularly summarized what they had learned about their scientists' perspectives to make this point; for instance, Wangari Maathai's conviction that "everyone should be a scientist because it is necessary to conserve the environment," and Lydia Villa-Komaroff's belief that science provides an "equal place for men and women of all backgrounds." One group noted that "Anyone can be a scientist—science does not discriminate." Another wrote that "Teachers need to be careful not to place scientists into a stereotype. They should be able to show that science can be found in everything and demonstrate science in all walks of life."

Students' Evaluations of the Assignment

General Impressions

Unlike students' reactions to the majority of assignments in any classroom, no students professed negative reactions to the "Becoming a Scientist" activity. If students did have these, it is possible that they would not report them as they might fear punitive reactions from their professor. However, some students were more enthusiastic than others and chose more interesting scientists. Some students were shy about role-playing; working in groups seems to ameliorate their fears. When students wrote about how they would implement this activity in their own teaching, however, there was a range of projections concerning how much choice they would allow for their own students. Some explicitly recognized that children would need assistance in finding appropriate scientists. In terms of the role-playing itself, most students said that children would enjoy dressing up and pretending to be their scientist. A small minority of students said that they would make the assignment more traditional, more like a book report, and have each student write up a formal report and share that with the class. For instance, one student said that she would have her students "hand in a one-page summary," and another wrote that her students "would need to find at least 5 facts . . . one fact on each index card." These preservice teachers apparently do not find the table (Figure 1) appropriate or sufficient for what they would want their own students to produce.

Students' Responses: Benefits of Role-Playing

When students are asked to write about their experience with the "Becoming a Scientist" exercise, positive responses are regularly the result. Here, we share representative student comments from one semester in response to the questions: "What did you learn from this activity?" and "What would you want your own students to learn from this activity?"

We begin with Tanisha, who wrote that the assignment "definitely taught me about diversity" and "has opened my eyes to many different kinds of science." Here she expands on these statements:

> I went into this activity with minimal scientific thought and came out with a better understanding of what and who science really is. With my students, I would want them to see the many different scientific angles; to know and learn that not everyone wears a coat and is in a lab.

As it did for Tanisha, this assignment helped Amber see diversity in science:

> My scientist . . . had been the first pilot and commander of a space shuttle. . . . Now my "stereotype" of what a scientist should be has changed. . . . If I did this with my students, I would want them to learn what I did—that science can be done and studied by anyone, anywhere, and not just White males.

Laura noted that "Some of the scientists presented were from fields I never thought of as science related—for example, the dry cleaner and the gynecologist." Savannah "learned that various women have contributed to the science field," and wrote, "I don't understand why these great women are never discussed in

school." It appears that seeking out and learning about a scientist who breaks the stereotypical mold, coupled with the sharing of this learning with their classmates, convinces students that the stereotypes are misleading—that is, as Kristy put it, "a scientist is more than just someone working in a lab," and neither are they all geeky White men.

Some students' responses focused on the role-playing aspect of the activity. Describing what it meant to her and what it might mean to children to "take on the role of a scientist," Jessalyn wrote,

> It was empowering and I felt a sense of pride talking about my scientist. . . . I would want [my students] to take on the role of a scientist in order to empower children; also to learn how to use their imagination and become their scientist.

Celia studied Marie Curie, a familiar name to her and yet an unknown personality, welcoming "the opportunity to learn about her life." For her future students, she believed that "[b]y becoming the scientist, the child would feel more connected to their person and would be more enthusiastic about sharing their lives" with other students. Katie concurred, writing that "putting it in first person . . . made it much more interesting. . . . I think that children love acting, so I would make them pretend to be the scientists as well and hope the results would be as effective." Marcy was less specific, but she captured the positive thoughts students had about this interactive way of learning about scientists' lives by stating that she "learned a creative way to learn about a scientist instead of the same old book report way."

As prospective teachers, students' appeared to recognize the power of role-playing as a pedagogic strategy. Equally important was students' emphasis on the concept that all kinds of people do all kinds of science. Mark, the only male student in this elementary methods course, powerfully sums up the main point of this role-playing assignment:

> Men and women of all kinds of races, backgrounds, parts of the world, and segments of time do and have done science. The types of science are many, including engineering, psychological, environmental, astronomical, and social. . . . I would want [children] to learn that science and scientists come in many different shapes and sizes, [and] that they too are scientists.

We believe that students make progress in their understanding of the diversity of science and scientists through this exercise, at least in part because they are able to step outside of stereotypical visions and into realities that they find appealing and accessible. This role-playing activity gives students the opportunity to explore the question "Who does science?" more deeply and, in the process, challenge stereotypes and expand their visions of what science and scientists have been and could be. Through this realization, prospective teachers can identify ways to help students—all students—connect to science.

Caveats and Lessons Learned

As with any teaching methodology, role-playing has its caveats. Fortunately, the rewards far outweigh the inherent risks involved. Based upon both the existing literature and our own learning through this study, we believe that the following are wise to keep in mind to maximize success when utilizing this strategy:

- *Careful Planning:* As with any active learning strategy or project, thoughtful planning on the part of the professor is essential. Resources, time allocation, and the integration of content and skills all must be considered ahead of time. This type of exercise requires up-front preparation to ensure that students have the time and the support in searching out scientists. The initial class session in which students drew scientists and discussed stereotypes provided a foundation for the role-playing assignment. Without this, the "Becoming a Scientist" assignment might seem to come out of the blue. Thus, we are convinced that a session dedicated to revealing and critiquing stereotypes provides the impetus for searching out scientists whose lives and backgrounds belie these stereotypes.

- *Democracy in the Classroom:* It is important to allow students to select the scientists they are to research and role-play. In addition to conferring a certain degree of autonomy and voice in the classroom, it is imperative that students be highly interested and motivated in their topic given the nature of these projects. It stands to reason that the more input students have, the more engagement and involvement will be generated. Given this independence, students regularly exceed expectations and turn the assignment into a rich learning experience for professors as well as for students. However, this freedom of choice is in tension with persuading students to choose scientists who strongly contradict stereotypical visions and who provide powerful real-life images of the notion that people of both genders and all races and ethnicities participate in scientific activity. Nonetheless, we believe that student choice is important for the reasons named above, as well as because the students regularly discover scientists of whom the professor did not know or make choices that are outside of even the professor's boundaries concerning "Who does science?"

  In other words, we recognize that some students stay closer to what they are used to rather than reaching out to explore people who they perceive to be outside the norm. Again, even those students who choose people who might seem typical to us (e.g., Marie Curie, Jane Goodall, and Nicola Tesla) tend to find out things about these scientists that surprise them—that is, the scientists become more "human"—and the interpretations the students develop for their scientists' responses to the question "What is science?" regularly contradict the dull, antisocial stereotypes that prevail in society and in their initial drawings.

- *Expectations for Learning:* Role-playing can be so enjoyable that sometimes students might think they are just having fun and not realize the amount of learning that is occurring. As Fennessey (2000) points out, making expectations clear—for both social and academic goals—is an important step in ensuring success with this strategy. Evaluating students in role-playing is not as clear-cut as traditional forms of assessment. In addition to assessing students on the "performance" aspect of the exercise, students should also be accountable for their research, preparation, and collaboration with peers. With this assignment, the chart (see Figure 1) helps to fulfill the demands of assessment. When this chart is not required, some students would have no notes and, accordingly, have little to say, while others would write pages and take up an inordinate amount of time reading their text (or presenting elaborate posters or demonstrations). While these latter cases could be wonderfully enlightening for all, they were

not practical in a large course and made the activity go longer than the initially allotted time. Using the chart as the students did in this study also provides the professor with insight into each student's learning and beliefs—information that most likely would not be obtained during the group presentations.

- *Closure:* Although it is tempting to have the role-playing performance serve as the culmination in the instructional sequence, bringing closure to the experience should include a formal closure or debriefing session. Students have questions about the motivations of their characters, the professional parameters of the time period in which they lived, or queries about science in general. The professor must help students bring closure to the experience by reflecting on their own learning. This has not been done in this course other than through written reflections due to time constraints. This issue argues further for collaborating with other subject-matter methods professors so as to provide students with further opportunities to discuss stereotypes and prejudices in science as well as in other disciplines and professions. In particular, collaboration with social studies methods professors might help students develop their understanding of the sociology and history of science and assist them in developing authentic interdisciplinary curriculum for their own students.

- *Future Teaching:* Prospective teachers are much more likely to utilize instructional strategies they see modeled in their methods class (Palmer, 2006). Having participated in role-playing as a student results in increased confidence in executing role-plays as teachers. Some students intend to use the assignment exactly as given; some plan to make it more elaborate (e.g., insisting on the dressing up option); and others aim to fit the activity into a more traditional report-like form. However, all students report that this is something they will very likely use in their own teaching with children.

In summary, using role-playing in science education can be beneficial in a number of ways. It can lead to more authentic learning, develop multiple perspectives, and help preservice teachers practice and sharpen their presentation skills (Metz, 2005). Moreover, role-playing is especially effective in conveying social history, "not the generals or the political leaders, but rather on the people who do their jobs—those the headlines usually miss" (Morris, 2001, p. 52). Although some of the lessons learned by prospective teachers might be perceived as simplistic (e.g., "anyone can be a scientist"), this may be the beginning of larger shifts in thought. Incorporating marginalized groups into the teaching of science can help students conceptualize science in a more inclusive manner while developing empathy and understanding of the relative challenges and opportunities of living in another era or different culture, working with ongoing barriers put up by a highly prescribed and often still prejudiced field.

For Further Reading

The following annotated bibliography is by no means exhaustive, but the works cited here provide a helpful overview of role-playing as a teaching strategy within the broader field of experiential education.

Beard, C., Wilson, J. P., & Irvine, D. (2002). *The power of experiential learning: A handbook for trainers and educators.* London: Kogan Page.
This text provides theoretical perspectives as well as suggestions for practice in experiential education. The workshop-based examples are easily adaptable for classroom use.

Blatner, A. (2008). *Role playing in education*. Retrieved May 20, 2009, from www.blatner.com/adam/pdntbk/rlplayedu.htm.
This essay provides a historical background for role-playing as a teaching strategy and discusses some of the problems associated with it, including ways to avoid them in the classroom.

Hertel, J. P., & Millis, B. J. (2002). *Using simulations to promote learning in higher education: An introduction.* Sterling, VA: Stylus Publishing.
In addition to guidance on selecting and designing scenarios to meet learning objectives, the authors offer practical advice on classroom management, debriefing, and assessment. Sample scenarios and examples of documentation are also provided.

Moon, J. (2004). *A handbook of reflective and experiential learning: Theory and practice.* New York: RoutledgeFalmer.
Written for a wide and varied audience, this book nonetheless is helpful for understanding both the theoretical underpinnings and practical application of experiential learning strategies. The author also provides practical classroom advice as well as reproducible resources.

Shaffel, F. R., & Shaftel, G. (1982). *Role playing in the curriculum*. Englewood Cliffs, NJ: Prentice Hall.
This book covers the theory and methodology associated with role-playing as well as advice for professors on how to guide and manage the process in the classroom. Also included are discussions on using role-playing in preservice and inservice teacher education.

Silberman, M. L. (2007). *The handbook of experiential learning*. New York: Pfeiffer.
This comprehensive resource discusses a wide range of experiential learning strategies, including role-playing.

Teachers Curriculum Institute. (2005). *Bring learning alive!* Rancho Cordova, CA: Author.
Although targeted for social studies educators, this resource deftly illustrates the role-playing methodology through in-depth discussion, sample lesson plans, and reproducible classroom resources.

Teed, R. (2008). *Role-playing exercises*. Retrieved May 20, 2009, from http://serc.carleton.edu/introgeo/roleplaying.
This helpful website discusses role-playing as a strategy, providing dozens of free role-playing, science-oriented scenarios and links to a number of articles and essays on the subject.

Thompson, J. F. (1978). *Using role playing in the classroom*. Bloomington, IN: Phi Delta Kappa Educational Foundation.
This guide provides an overview of role-playing as an instructional strategy and discusses specific techniques for professors to use. Also included are examples of role-play activities.

Wurdinger, S. D. (2005). *Using experiential learning in the classroom: Practical ideas for all educators*. Lanham, MD: Scarecrow Education.
This book provides valuable support for high school and college teachers who want to move beyond the typical lecture and text-based format. The focus throughout is on teaching subject matter in ways that students find relevant. Assessment strategies are also provided.

References

Alden, L. (2005). Birka: A trading game for economics students. *Social Studies, 96*(4), 178.

Anema, D. (2005). *Ynes Mexia: Botanist and adventurer*. Greensboro, NC: Morgan Reynolds Publishing.

Arce, C. (2006). Molting mania. *Science and Children, 43*(7), 28-31.

Beck, J. A., & Czerniak, C. M. (2005). Invasion of the zebra mussels: A mock trial activity. *Science Activities: Classroom Projects and Curriculum Ideas, 42*(1), 15-19.

Blatner, A. (2006). Enacting the new academy: Sociodrama as a powerful tool in higher education. *RE:view: Rehabilitation Education for Blindness and Visual Impairment, 28*(3), 30-35.

Borbely, C. J., Graber, J. A., Nichols, T., Brooks-Gunn, J., & Botvin, G. J. (2005). Sixth graders' conflict resolution in role plays with a peer, parent, and teacher. *Journal of Youth and Adolescence, 34*(4), 279-291.

Brown, T. C., Li, S. X., Sargent, L. D., & Tasa, K. (2003). What went wrong at University Hospital? An exercise assessing training effectiveness. *Journal of Management Education, 27*(4), 485-496.

Buck, G. A., Leslie-Pelecky, D., & Kirby, S. K. (2002). Bringing female scientists into the elementary classroom: Confronting the strength of elementary students' stereotypical images of scientists. *Journal of Elementary Science Education, 14*(2), 1-9.

Capobianco, B. (2007). A self-study of the role of technology in promoting reflection and inquiry-based science teaching. *Journal of Science Teacher Education, 18*, 271-295.

Dinkelman, T. (2003). Self-study in teacher education: A means and ends tool for promoting reflective teaching. *Journal of Teacher Education, 54*(1), 6-18.

Dollarhide, C. T., Smith, A. T., & Lemberger, M. E. (2007). Counseling made transparent: Pedagogy for a counseling theories course. *Counselor Education and Supervision, 46*(4), 242-253.

Doron, I. (2007). Court of ethics: Teaching ethics and ageing by means of role-playing. *Educational Gerontology, 33*(9), 737-758.

Feldman, A., & Minstrell, J. (2000). Action research as a research methodology for the study of the teaching and learning of science. In A. E. Kelly & R. A. Lesh (Eds.), *Handbook of research design in science and mathematics teaching* (pp. 429-456). Mahwah, NJ: Lawrence Erlbaum.

Fennessey, S. M. (2000). *History in the spotlight: Creative drama and theatre practices for the social studies classroom*. Portsmouth, NH: Heinemann.

Finson, K. D. (2000, January). *Investigating preservice elementary teachers' self-efficacy relative to self-image as a science teacher*. A paper presented at the annual international meeting of the Association for the Education of Teachers of Science, Akron, OH.

Finson, K. D. (2002). Drawing a scientist: What we do and do not know after fifty years of drawings. *School Science and Mathematics, 102*(7), 335-345.

Fox, A. M., & Loope, L. L. (2007). Globalization and invasive species issues in Hawaii: Role-playing some local perspectives. *Journal of Natural Resources and Life Sciences Education, 36*, 147-157.

Glaser, B., & Strauss, A. (1967). *The discovery of grounded theory: Strategies for qualitative research*. Chicago: Aldine.

Hughes, E. H. (1971). Role playing as a technique for developing a scientific attitude in elementary teacher trainees. *Journal of Research in Science Teaching, 8*(2), 113-122.

Jackson, P. T., & Walters, J. P. (2000). Role-playing in analytical chemistry: The alumni speak. *Journal of Chemical Education, 77*(8), 1019-1026.

Kocarek, C. E., & Pelling, N. J. (2003). Beyond knowledge and awareness: Enhancing counselor skills for work with gay, lesbian, and bisexual clients. *Journal of Multicultural Counseling and Development, 31*(2), 99-112.

Lebaron, J., & Miller, D. (2005). The potential of jigsaw role playing to promote the social construction of knowledge in an online graduate education course. *Teachers College Record, 107*(8), 1652-1674.

Maddrell, A. (2007). Teaching a contextual and feminist history of geography through role play: Women's membership of the royal geographical society (1892-1893). *Journal of Geography in Higher Education, 31*(3), 393-412.

McAdam, J. E. (1990). The persistent stereotype: Children's images of scientists. *Physics Education*, 25, 102-105.

McDaniel, K. N. (2000). Four elements of successful historical role-playing in the classroom. *The History Teacher, 33*(3), 357-362.

Metz, D. (2005). Field based learning in science: Animating a museum experience. *Teaching Education, 16*(2), 165-173.

Mitri, M., & Cole, C. (2007). A systems analysis role play case: We sell stuff, Inc. *Journal of Information Systems Education, 18*(2), 163-168.

Morris, R. V. (2001). Using first-person presentation to encourage student interest in social history. *Gifted Child Today, 24*(1), 46-53.

Muncy, J. A. (2006). Implications of contemporary intelligence theories to marketing education. *Journal of Education for Business, 81*(6), 301-306.

Palmer, D. H. (2006). Sources of self-efficacy in a science methods course for primary teacher education students. *Research in Science Education, 36*, 337-353.

Poorman, P. B. (2002). Biography and role playing: Fostering empathy in abnormal psychology. *Teaching of Psychology*, *29*(1), 32-36.

Rahm, J. (2007). Youths' and scientists' authoring of and positioning within science and scientists' work. *Cultural Studies of Science Education*, *1*, 517-544.

Roth, K. J. (2007). Science teachers as researchers. In S. K. Abell & N. G. Lederman (Eds.), *Handbook of research on science education* (pp. 1205-1259). Mahwah, NJ: Lawrence Erlbaum.
Shearer, R., & Davidhizar, R. (2003). Using role play to develop cultural competence. *Journal of Nursing Education, 42*(6), 273-276.
Smythe, M. A., & Higgins, D. A. (2007). (Role) playing politics in an environmental chemistry lecture course. *Journal of Chemical Education*, *84*(2), 241.
Van Assendelft, L. (2006). "It's the Supreme Court, stupid": A simulation approach to feminist teaching. *Feminist Teacher, 16*(3), 216-224.
van Zee, E. H., & Roberts, D. (2001). Using pedagogical inquiries as a basis for learning to teach: Prospective teachers' perceptions of positive science learning experiences. *Science Education, 85*, 733-757.
Wilcox, D. R., & Sterling, D. R. (2006). Twisters, tall tales, and science teaching. *Science Scope, 29*(8), 36-41.
Woodward, W. W. (2003). The trial of Katherine Harrison. *OAH Magazine of History, 17*(4), 37-42, 56.

Correspondence regarding this article should be directed to

Elaine V. Howes
Assistant Professor of Science Education
Department of Secondary Education
University of South Florida
4202 E. Fowler Avenue
Tampa, FL 33620-5650
(813) 974-2816
Fax: (813) 974-2816
ehowes@coedu.usf.edu

Manuscript accepted September 18, 2008.