

LEAD BY DESIGN: PEDAGOGICAL APPROACHES TO FOSTER REFLECTIVE PRACTICE AND CAREER-LONG SUSTAINABLE PROFESSIONAL DEVELOPMENT

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Abstract: In the 21st century, practicing engineers are working under conditions of rapid change, both in the technologies of engineering as well as in the contexts in which engineering is practiced. The “grand challenges” of today and of the future require a broad range of knowledge and skills, and the capacity to connect engineering with other sectors. To respond, universities must educate engineers who understand engineering principles at fundamental levels, but who also have nimble design and process skills. This paper presents findings from a research project that developed, implemented and evaluated new diversity-attracting integrative pedagogies intended to tap into the motivations and values that engineering students bring to their work and study. Our initiative responds both to the changing demands on engineers and to ongoing efforts to increase the retention of women in the profession. Our research findings show the importance of narratives in fostering the reflective practice that can underpin both a sense of identity as an engineer and professional sustainability.

1 INTRODUCTION

In the 21st century, practicing engineers are working under conditions of rapid change in technologies, as well as changing socio-political conditions at the local, national, and global levels. Change is anticipated to be a reality over the careers of current and future engineering students, whose engineering careers might extend well into the middle of the 21st century. Although it is difficult to predict exactly how ongoing change will contribute to future engineering knowledge and practice, we can expect that the “grand challenges” of today and of the future (NAE 2008) will require a broad range of new knowledge, new skills, and new connections of engineering with other sectors to solve the problems we may collectively face. To respond to these challenges, universities must educate engineers who understand engineering principles at fundamental levels, but who also have nimble design and process skills that will enable them to work on interdisciplinary teams, provide leadership to self and others, and integrate a wide range of relevant factors into innovative engineering solutions.

At the same time, the rates of women entering engineering studies remain low in Canada, and the long-term rates of participation in the profession are even lower (Engineers Canada 2014). While the low participation rates of women in engineering are influenced by many factors, they are symptomatic of the need for change within engineering education and practice; indeed Calnan and Valiquette (2010) refer to women as the proverbial canaries in the engineering coal mine. Increasing the participation rates of women and of other diverse groups in engineering requires both recruitment and longer-term retention strategies. Retention in engineering, in both the short and long term, can be fuelled by positive experiences of university-level engineering education. We (and others) argue that university engineering education must be transformed to foster the sustainability of the individual engineer over her or his career (Moloney 2010; Goldberg et al. 2014).

A key aspect of such sustainable engineering education is that it expand from its current dominant focus on the content material of engineering (which we have elsewhere called the “what” and “how” of engineering) to an appreciation and experience of the connected interdisciplinarity of engineering practice, layered upon the emerging self-understanding of the engineering student: the dynamic “who” and “why” of the person who aspires to be a scientist or engineer (Moloney and Rosales 2011). The absence of explicit advertence to the “who” and “why” can be linked to long historical structures within engineering education (Goldberg 2010).

Past research shows that identifying with engineering as a profession includes three necessary components: *thinking* like an engineer, *acting* like an engineer and *feeling* like an engineer (Herzig 2004; Moloney 2006). An explicit focus on the “who” and “why” within engineering education will enable the linking of the motivations and values that students bring to engineering with their innovative practice of engineering. This linkage will foster an important aspect of sustainable development in engineering, notably the career-long sustainability of engineering professionals in our changing world (and in particular for women and members of other diverse or under-represented groups). These engineers will produce better engineering solutions for the benefit of us all.

1.1 Purpose and Research Goals

The purpose of our research project was to propose, implement and evaluate new diversity-attracting integrative pedagogies that tap into the motivations and values that students bring to their work and study, including a sense of themselves as citizens engaged in understanding and meeting the complex challenges of our times, both locally and globally. While our efforts were aimed, in the first instance, at promoting women in engineering, we argued that the health of engineering requires broader change and engagement with diversity. Thus, inclusivity and a wide definition of diversity were important components for our research design.

The research questions we are interested to address are: 1) What motivates engineering (graduate) students in their career and life choices in engineering? 2) How can we develop innovative pedagogies to enhance the retention of women (and other diverse groups) in engineering and their long-term sustainability in the practice of engineering?

Towards answering these questions, and to study the relationships between diversity, identity, and professional success, we developed a five-day co-curricular course, called the “*Lead by Design* Institute on Leadership, Diversity and Dialogue for Graduate Students in Engineering.” This pilot program was offered to engineering graduate students at Memorial University, with the intention that the results of our research inform the design of similar pedagogies and programs for undergraduate engineering students in later projects. The structure and curriculum of the *Lead by Design* Institute are described in Section 3, and research findings concerning reflective practice and identity are presented and discussed in Section 4, along with discussion of their importance in fostering professional sustainability.

2 BACKGROUND

2.1 Integrative Pedagogies in Engineering

There is a growing literature on strategies to enhance the current-day relevance and longer-term sustainability of engineering education, based on a range of pedagogies. Our particular focus is on integrative pedagogies that aim to connect the person who is learning with the material being learned and its wider context, and thus make positive learning experiences and longer-term retention in engineering more likely. Engineering education researchers and practitioners have begun to argue that the established undergraduate engineering curricula do not respond adequately to the needs of the present, much less to those of the future (Grasso and Burkins 2010; NAE 2005; Reeve 2010; Sheppard et al. 2008). Established engineering programs tend to educate students to be specialized and technical problem-solvers within their disciplines. However, the 21st century context of engineering, as well as much of current engineering practice, points to benefits when engineers are problem-definers as well as problem-solvers (Sheppard et al. 2008), and more significantly, are able to engage in socially responsible

and interdisciplinary collaboration (Goldberg 2010). Such a systemic transformation would include not only an integration across the disciplines but also greater emphasis on: building teams and teamwork; the development of more effective communications skills; cross-disciplinary dialogue, and dialogue between humans and their objects of study; increased awareness of the social, political, environmental, commercial and government contexts of engineering and science (Sheppard et al. 2008); and methods to heighten awareness of self (Moloney 2010).

Research into, and the practice of, integrated engineering education are demonstrated in several programs in Canada—such as University of Toronto's Leaders of Tomorrow (Reeve 2010) and the MetaKettle Project at Memorial University (Moloney and Rosales 2011)—and in the United States, such as at Smith College (Grasso and Burkins 2010) and Olin College (Sheppard et al. 2008). Programs in other disciplines, such as the Undergraduate Semester in Dialogue at Simon Fraser University in Vancouver, Canada (Gunnlaugson and Moore 2009) demonstrate successful program elements that can provide inspiration for engineering education.

The need for transformation in engineering education is most notable at the undergraduate level, but is also significant for graduate studies. The graduate student experience in engineering is marked by a deeper and more focused engagement with the “what” and “how” of an area of engineering, as well as the need for greater self-motivation. The latter points to a heightened need for a self-understanding of “who” and “why,” as well as a heightened need for leadership on the part of graduate students (Moloney 2006). Graduate students may not view themselves as leaders in their graduate studies, in part because the graduate student experience in engineering can be one of working alone on one's own research, or of working as a member of a supervisor's lab team. Professional development for leadership is crucial, since without a strong sense of agency it is very hard to be a discoverer, or an intellectual leader of oneself or others. Moreover, graduate students do provide leadership for one another in their lab communities, and leadership will be expected of graduates entering the workplace with higher degrees (Cohen and Cohen 2012). For women graduate students, as well as for any other under-represented groups, it is important to develop a strong sense of autonomy, self-direction, and leadership, not just from the perspective of having power *over*, but also of having power *to*, that is, the power to do something (Freeman et al. 2001; Williams and Emerson 2008).

2.2 Reflective Practice and Narratives

Since engineers regularly engage with design and problem solving, developing reflective skills is a key element in the ongoing professional development of engineers. Professionals often face conflicts in values, goals, purpose and interests, and there can be competing views about practice. Reflective thinking is one way that professionals can successfully navigate these conflicts, through a cycle of questioning that allows an individual to examine his or her experience in order to derive meaning from it (Gibbs 1988). Reflective practice attempts to explore the boundaries between one's professional work, the multifaceted demands of the outside world, and the dynamics of one's inner life. Ultimately, reflective practice should lead to constructive action and change. In many professional practices reflection can become routinized and uncritical (Galea 2012); uncritical reflection can then re-enforce bias, inequalities and discriminations rather than expose them. A way around this focusses on *reflexivity* as a core concept (Bolton 2010). While reflection is examining what we think, reflexivity is the ability to look back in on ourselves, to recognise our own influence, within a context, as an agent in the practice we're involved in (Thompson and Pascal 2012).

Reflective writing is meant to be a spontaneous form of writing (also called “free-writing”), used as a means of critical reflection. Writing “involves taking the unprocessed, raw material of experience and engaging with it as a way to make sense of what has occurred. It involves exploring often messy and confused events and focusing on the thoughts and emotions that accompany them” (Boud 2001, p. 10). Free-writing is non-stop stream-of-consciousness writing for a timed period, such as for 2-5 minutes. The idea is not to cross out or re-read what is being written but to keep going forward, writing everything down without criticizing or judging, thus keeping the inner critical voice quiet. The results are often quite surprising in terms of the insights at which one may arrive. Free-writing is a form of personal writing, even if oriented towards a professional topic, and the process is meant to enable a greater sense of self-

awareness. Reflective practice is thus a key process skill for engineers to advert to their sense of identity as engineers, and for students and young engineers to become more aware of the process of identification with the profession and to work through areas of dissonance in their identity.

Free-writing as a reflective practice often produces elements of one's personal narrative. From the perspective of research, narratives are a popular source of data in qualitative research (Merriam 2009). In the social sciences there is a long history of narrative inquiry and analysis. While it has roots in late 19th Century scholarship, the last three decades have seen a boom in this type of inquiry. Constructivist, postmodern and performance philosophies have fed the growth in narrative approaches (Specter-Mersel 2010). Data thus collected can include stories people tell about their identities, values, relationships and experiences. The purpose of collecting narrative data is to tap into the meanings respondents attach to issues and to actions taken. A narrative approach is a distinct inquiry into human nature. In other words, narratives hold answers to peoples' experiences and the meanings they attach to how they understand processes around experiences (Merriam 2009). Narrative methodologies are not new to engineering (Pawley 2009), and have proved valuable for tapping into the less technical, content-related aspects of the field. For research on women in particular, narratives have proved to be a well-matched methodology (Sahib and Vassileva 2009).

3 LEAD BY DESIGN INSTITUTE

3.1 Description of Institute

The *Lead by Design* Institute was a co-curricular program that brought together 14 graduate students from the Faculty of Engineering and Applied Science at Memorial University for a five-day workshop in April 2014. Participants took part in a variety of leadership, communication, reflective-practice and skill-building workshops and explored questions such as: "What is engineering?", "What attracts you to engineering?", "What makes an empathic engineer?", "How will you contribute to redesigning engineering?", etc.

3.2 Curriculum Development

The objective of the *Lead by Design* Institute was to develop and implement a pedagogy to attract and retain more women and other diverse groups in the engineering profession by focusing on issues related to personal development and social justice. From the objective of developing an "ideal" pedagogy that would attract women and other diverse groups to engineering, the curriculum developed through an iterative process. The curriculum plan that unfolded into detailed plans and materials for Days 1-5 was developed around a thematic arc of "Understanding how we got where we are, designing (engineering) a new future," with a focal point on Day 4, "Re-engineering the foundations of my career." The curriculum consisted of three threads: 1) reflective practice; 2) dialogue to heighten personal, ethical and social awareness; 3) self-awareness, leadership and including yourself in the technical aspects of engineering. Specific activities included: skills building; dialogues and reflections; case studies in leadership and diversity; and a team-project on an engineering "challenge." The challenge culminated in a technical solution that students explained using a "non-standard form" (debate, skit, poetry, art, etc.) presented at a public Engineering Salon.

3.3 Research Methodology

As a research project, the *Lead by Design* Institute project is based on theories and methods in: dialogue-based education (Gunnlaugson and Moore 2009); reflective practice (Bolton 2010); leadership of self and others (Cohen and Cohen 2012); feminist and other theories of liberation (Friere 1970); and the connection of affect with success (Csikszentmihalyi 1990), and in particular the cognitive and affective interactions involved in attraction to and identification with engineering (Turkle 2008). The project is also informed by other novel and emerging approaches to more integrative engineering education (e.g. Goldberg et al. 2014) including the integration of challenging technical materials in engineering with appreciation of one's thinking, acting and feeling like an engineer (Moloney 2006).

We conducted a basic qualitative study combined with descriptive survey results. A basic qualitative study is often found in applied fields of practice where data is collected through interviews, observations and document analysis. An assumption within this type of research is that individuals, e.g. the participants in the study, construct reality as they engage with their social world. Our purpose was to explore this engagement by examining a) how participants interpret their experiences; b) what these experiences mean to them, all in an effort to understand how people make sense of their experiences (Merriam 2009).

Several types of data were collected throughout the *Lead by Design* Institute, including (i) narratives and reflective writings; (ii) a pre- and post-institute survey; (iii) photographs of sessions, (iv) a video of the challenge presentation; and (v) the written observations of the researchers. Among the items in category (i), an important subset were the free-writes, and, for this paper in particular, those that included comments on identity, values and choices in engineering. One idea behind the free-writes was to ascertain how the students identify themselves as engineers, and what form and shape that identity takes. Furthermore, we wished to obtain insights into the processes that inform identity-building.

Throughout the *Lead by Design* Institute, participants were asked to free-write on several topics each day. Topics of the free-writes included reflections on the previous day(s), or were constructed to be directly related to the research questions in Section 1.2. While participants were engaged in free-writing at least one researcher recorded observations of the participants (per Merriam 2009) and how they were reacting to the experience of free-writing.

4 RESULTS AND DISCUSSION

Our research findings from the 2014 *Lead by Design* Institute indicate the importance of writing and narratives in fostering the reflective practice that can underpin both professional identity and professional sustainability. Indeed, analysis of our data show that the narratives and reflective practice were key to eliciting statements about identity and professional sustainability.

4.1 Narratives and Reflective Practice

The free-writes in the *Lead by Design* Institute employed the same technique previously used by the researchers (Rosales et al. 2012), based on (Badenhorst 2008). Participants were invited to write in landscape mode, using coloured paper and fine-tipped markers, as these aesthetic differences separated the free-writing activity from the often anxiety-laden task of academic writing.

Initially participants were a bit reluctant to free-write with coloured markers and paper, but we observed an increasing ease with the free-writing over time, to the point where by the end of the Institute participants wrote with ease, and even eagerly engaged with each new free-write topic. Moreover, quantitatively, the average word count per free-write increased over the Institute, from 54 words per free write on Day 1 to 107 words per free-write on Day 5.

From the post-Institute survey, in response to “The free-writing exercises helped me to understand my identity as an aspiring engineering professional,” all Agreed, 7.1%, or Strongly agreed, 92.9% (N= 14). In response to a post-Institute survey question on what activities were most helpful or insightful for their professional development, participants wrote (with participant names anonymized):

- *“Free-writing was the most helpful and insightful because I actually was putting my thoughts into words ... I think it was the best thing from this institute.”* (Maxwell)
- *“Free-writing. It’s a way to reflect my deep thought without any boundary and dig up some information I didn’t realize. It’s a way to think deeper and have a conversation with myself.”* (Stephen)

Looking more closely at the content of the free-writes, we can find insightful comments from participants. On Day 1, participants were introduced to free-writing and reflective practice, with five opportunities to free-write that day. Their writings on Day 1 tend to be less personal and more “academic” than those they

produced on subsequent Days. At the start of Day 2, participants were asked to free-write on, “What did you learn (or was significant) about yesterday?” Several responses cited free-writing:

- *“I was very amazed by the term “free writing”. I know this word from many years. But yesterday I understand it completely. ... I think through this kind of exercise you can relax your mind and it will also help someone to develop new ideas ...”* (Colt Tropper)
- *“... the greatest part was to learn about free writing and surprisingly after I started free writing it gave me a relaxing time also.”* (Melisa)
- *“Free writing: First time I heard about free writing. It was fun!! ... when I want to open up or when I want to start my thoughts to fall I will use this method in future.”* (Lilly)

By Day 4, in response to a free-write on, “Reflect on writing the narratives – what do you want to know?”, two participants wrote:

- *“My process of writing narratives became or gradually became good but slowly. ... However this exercise helped me to think deep & look into my history when I really select[ed] engineering.”* (Aji)
- *“It was not easy to look into the mirror and explore the deep thought in my mind. After a few times of practice it became much easy for me to write. ... reminding me that why I am here, doing what I am doing and being who I am. ... The answer sometime is very simple, right there in your hand.”* (Kelly)

One participant did express concern, though, about the challenge of adopting a new process:

- *“Other thing I want to know is how to keep this habit and apply to my works everyday.”* (T. Smith)

While the free-writings elicited personal insights, participants also noticed the transferability to their engineering work, such as on Day 3, in response to “What is something significant that you’ve learned this week?”:

- *“The free writing and narrative although daunting at first are liberating and I can see them as useful tools for writing my thesis.”* (Amy)

Overall, participants started narrative writing very reluctantly, as they were not familiar with it and were not used to self-reflection. But over five days of facilitation and positive experience in what became a friendly and supportive group, they came to enjoy the process and found benefits in the self-reflection.

4.2 Identity and Professional Sustainability

Identity is more difficult to extract from the free-writes than the reaction to free-writing process itself. A companion exercise on writing and multiple revision of a personal narrative on how they came to be in engineering (coupled with another exercise to bring in and speak to a physical object that inspired them when they were young, as in the manner of (Turkle 2008)) was explicitly oriented towards their professional identity. Some quotes from the free-writes attest to their growing insight into their professional identities. For example, on Day 4, in response to, “Re-engineering the foundation of your career”, one participant wrote:

- *“I still need to get to know more about my foundation, my value, motivation and vision. ... In an engineering perspect[ive] we could make something with a model and data. What I need to do is to gather(...) data for my foundation and set up a model. Give a try or shot, by trial and error. Being there means something.”* (Stephen)

Also as noted in Section 4.1, some participants looked forward to benefitting from using free-writing and reflective practice in their ongoing engineering careers. While we cannot claim that the Lead by Design Institute had a significant impact on the professional sustainability of the participants (that would need a longitudinal study), it is worthy of note that all 14 participants remained to the end of an intense 5-day

Institute. Indeed they left with thanks and enthusiasm. In a final Day 5 reflection on whether their undergraduate programs prepared them for graduate work, and what might be missing from their present studies, several participants indicated the importance of the process skills introduced in the *Lead by Design* Institute, both for themselves and for other graduate students. For example, two responses were:

- “*The chance to practice my soft skills was also very rare and I didn’t even know it is so important. Spring institute helps me once again to open my mind, to view myself as an engineer from different perspectives. This is fun.*” (Kelly)
- “*... I want programs and leadership courses like these to be made compulsory or part of degree programs at MUN so everyone benefits from it. Because it makes you a good engineer and you can excel more in the job market if you have such skills.*” (Maxwell)

5 CONCLUSIONS

According to its participants, the *Lead by Design* Institute provided an insightful co-curricular experience that argues in favour of the value of reflective exercises. As participant-observers, we witnessed the growing awareness/self reflection of the participants across the 22 free-writes and other activities of the Institute. The free-writes, personal narratives, session discussions, etc. were indicative of a growing realisation of their identity as engineers. While difficult to claim with significance, we can also suggest that this growth was aligned with a greater awareness of agency, i.e. the power to be the kind of engineer they want to be. Participants’ reflective practice enabled them to access insights into their previous personal experiences that had led them to choose engineering, and enabled them to see a continuity from those earlier experiences with their unfolding careers. Future work is needed to investigate the extent to which the experience of participating in the *Lead by Design* Institute can have an influence in enhancing their individual identity and professional sustainability over the longer term. As well, future work is needed to explore the implementation and evaluation of this pedagogical approach for a wider spectrum of engineering undergraduate and graduate students.

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References

- Badenhorst, C.M. (2007). *Research Writing: Breaking the Barriers*. Pretoria: Van Schaik.
- Bolton, G. (2010). *Reflective practice: Writing and professional development*, 3rd edition. London: Sage Publications.
- Boud, D. (2001). Using journal writing to enhance reflective practice. *New Directions for Adult and Continuing Education*, 90, 9-17.
- Calnan, J. and Valiquette, L. (2010). Paying heed to the canaries in the coal mine: Strategies that attract and retain more women in the engineering profession through Green Light Leadership. Engineers Canada. Retrieved from www.engineerscanada.ca/.
- Cohen, C.M. & Cohen, S.L. (2012). *Lab dynamics: Management and leadership skills for scientists*, 2nd edition. Cold Spring Harbor, NY: Cold Spring Harbor Press.
- Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience*. New York: Harper Collins.
- Engineers Canada (2014). Canadian engineers for tomorrow: Trends in engineering enrolment and degrees awarded 2009-2013. Retrieved from www.engineerscanada.ca/.
- Freeman, S.J.M., Bourque, S.C. & Shelton, C.M. eds. (2001). *Women on Power: Leadership Redefined*. Boston: Northeastern University Press.

- Freire, P. (1970). *Pedagogy of the oppressed*. New York: Herder and Herder.
- Galea, S. (2012). Reflecting reflective practice. *Educational Philosophy and Theory*, 44(3), 245-258.
- Gibbs, G. (1988). *Learning by Doing: A Guide to Teaching and Learning Methods*. Oxford: Oxford Further Education Unit.
- Goldberg, D.E. (2010). The missing basics and other philosophical reflections for the transformation of engineering education. In D. Grasso and M.B. Burins (Eds.), *Holistic engineering education: beyond technology* (pp.145-158). New York: Springer.
- Goldberg, D.E., Somerville, M. with Whitney, C. (2014). *A whole new engineer: The coming revolution in engineering education*. Douglas, Michigan: Three Joy Associates, Inc.
- Grasso, D. & Burins, M.B. (Eds.) (2010). *Holistic engineering education: beyond technology*. New York: Springer.
- Gunnlaugson, O. & Moore, J. (2009). Dialogue education in the post-secondary classroom: Reflecting on dialogue processes from two higher education settings in North America. *Journal of Further and Higher Education*, 33 (2), 171-181.
- Herzig, A. (2004). Becoming mathematicians: Women and students of color choosing and leaving doctoral mathematics. *Review of Educational Research*, 74 (2), 171-214.
- Merriam, S.B. (2009). *Qualitative research: A guide to design and implementation*. San Francisco, CA: Jossey-Bass.
- Moloney, C. (2006). The Graduate student leader. A workshop for women graduate students in science and engineering. Presented at 11th CCWESTT National Conference for the Advancement of Women in Engineering, Science, Trades and Technology (CCWESTT 2006), Calgary, AB, June 23-25.
- Moloney, C. (2010). 'Understanding' understanding across the disciplines: towards strategies for sustainable engineering education for the 21st century. Proceedings from IEEE/IBM Conference on Transforming Engineering Education: Creating Interdisciplinary Skills for Complex Environments, April 7-9, Dublin, Ireland.
- Moloney, C. & Rosales, J. (2011). The MetaKettle project: A journey to the heart of higher education. Proceedings from 15th International Conference of Women in Engineering and Science, July 19-22, Adelaide, Australia.
- National Academy of Engineering (NAE) (2005). *Educating the engineer of 2020: adapting engineering education to the new century*. Washington, DC: National Academies Press.
- National Academy of Engineering (NAE) (2008). NAE grand challenges of engineering. Retrieved from www.engineeringchallenges.org/cms/challenges.aspx.
- Pawley, A.L. (2009). Universalized narratives: Patterns in how faculty members define 'Engineering'. *Journal of Engineering Education*, 98 (4), 309-319.
- Reeve, D.W. (2010). There is an urgent need for engineering leadership education. *Engineering Leadership Review*. May, 1-6.
- Rosales, J., Moloney, C., Badenhorst, C., Dyer, J. & Murray, M. (2012). Breaking the barriers of research writing: Rethinking pedagogy for engineering graduate research. Proceedings Canadian Engineering Education Association (CEEA12) Conference, June 17-20, Winnipeg, MN.
- Sahib J. & Vassileva, J. (2009). WISEtales: Sharing Personal Stories as Informal Learning Experience for Women in Science and Engineering. From *Proceedings of the 3rd IEEE Intn'l Conf on Digital Ecosystems and Technologies*, Istanbul, Turkey, 1-3 June.
- Sheppard, S.D., Pellegrino, J.W. & Olds, B.M. (2008). On becoming a 21st century engineer (Guest editor's forward). *Journal of Engineering Education*. July, Special Issue on Educating Future Engineers: Who, What, and How, 97 (3), 231-234.
- Spector-Mersel, G. (2010). Narrative research: Time for a paradigm. *Narrative Inquiry*, 20 (1), 204-224.
- Thompson, N., & Pascal, J. (2012). Developing critically reflective practice. *Reflective Practice: International and Multidisciplinary Perspectives*, 13(2), 311-325.
- Turkle, S., ed. (2008). *Falling for science: Objects in mind*. Cambridge, MA: The MIT Press.
- Williams, F.M. & Emerson, E. (2008). *Becoming leaders: A practical handbook for women in science, engineering and technology*. Reston, VA: American Society of Civil Engineers.