



## Overview: The Role of Self Authorship in SET and Engineering Education



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Confronting stereotypes, dealing with glass ceilings, juggling the demands of work and family, and feeling pressure in the face of doubt about their ability and commitment are among the challenges faced by women entering male-dominated fields in science, engineering, and technology (SET). Because these challenges involve how people construct meaning from their experiences, the theoretical construct of self-authorship offers an important addition to the frameworks used to understand women's experiences in SET fields. Self-authored individuals define their own ideas and values and seek relationships defined by mutuality. They have an internal sense of self and the mental agility to evaluate different points of views to reach conclusions about what to believe. Self-authored women, therefore, are likely to be more resilient in the face of the obstacles they encounter when pursuing a career more often held by men. Educators' efforts to promote self-authorship could be instrumental in improving the representation of women in scientific and technical careers.

This literature overview is designed to be a guide for instructors, support staff, and outreach professionals who wish to use self-authorship as a tool to expand the presence of women in SET fields. We anticipate a broad audience including faculty and secondary teachers, advisors and mentors, and K-12 educators in formal and informal women in science or engineering programs. While research specifically focused on self-authorship in SET is only now emerging, this literature review is an invitation for K-16 educators to consider ways that promoting self-authorship can advance program goals.

The concept of self-authorship describes a developmental state that is achieved when an individual has transitioned from relying on others to relying on self to define one's knowledge, values, and relationships. The process of becoming self-authored involves a journey in one's cognitive, intrapersonal, and interpersonal awareness from an external to internal way of making meaning of experiences. The cognitive dimension refers to an individual's ideas about knowledge. The intrapersonal dimension refers to identity, or a sense of self. The interpersonal dimension refers to how individuals approach relationships. The three dimensions combine to form what Baxter Magolda refers to as a "self-authored system" through which individuals understand the world (2008). The more mature one's development in these three dimensions, the more likely she or he is to operate using an internal framework (Baxter Magolda & King, 2004).

An example of the evolution of self-authorship process is evident in the college student who progresses from looking to "experts" (e.g., teachers and parents) for "correct" answers to learning how to evaluate the opinions of others. For traditionally-aged students, the college years are a pivotal period when many individuals begin to question reliance on authorities and strengthen their own identity. Educators are in a unique position to support students' development toward a more self-authored frame of mind. Baxter Magolda described this role as helping students to reduce "external noise" from peers, authorities, and society so that they may develop an internal voice (2008, p. 282).

Kegan (1994) explained that the capacity to self-author one's life is pivotal to one's ability to handle the demands of a complex society. Employers and graduate schools expect graduates to be able to understand complicated concepts, evaluate diverse perspectives, and make judgments about complex ethical and moral issues. Graduates must also learn how to develop healthy interpersonal relationships in both their professional and personal lives. Finally, graduates will be challenged to engage with various communities, which requires an awareness of personal values and commitments without disregarding the needs and interests of others. Self-authorship serves as a foundation for other learning outcomes, such as problem solving skills, leadership ability, and intercultural effectiveness. The self-authored student is more likely to graduate having developed the range of skills required to become an effective citizen in a complex society (Baxter Magolda & King, 2004).

### **Self-Authorship Theory and Definitions**

Self-authorship is distinct from constructs such as self-confidence, self-efficacy, and agency that reflect an emphasis on autonomy and individuality. Self-authorship does not involve one's sense of confidence, goals, or actions, but rather one's ability to make meaning from an internally defined sense of self. The construct focuses on the reasoning an individual uses to reach conclusions and make choices rather than the choice itself.

The construct of self-authorship has been defined in several ways, beginning with Robert Kegan (1982, 1994) who identified five stages of development or what he called "orders of consciousness." Each successive order of consciousness is defined by a more complex level of thinking, meaning that individuals are able to reflect on ideas of which they had previously been unaware. For example, individuals in Kegan's third order may become sensitive to cultural, ethnic, and gender differences. It is not until they move into fourth order that they can meaningfully reflect on those to make a conscious commitment to a personally constructed system of values and beliefs.

Baxter Magolda's research (2001) builds upon Kegan's work and involves an ongoing longitudinal study that has followed a group of individuals from their college years into adulthood. She distinguished three distinct phases of the self-authorship journey that are most prevalent among college students: *following external formulas*, *the crossroads*, and *becoming the author of one's own life*. An individual's progression through these phases represents a shift from reliance on external authorities to make meaning of the world to the emergence of one's internal voice. Dissonance between an individual's current phase of development and the demands of the environment, such as interaction with others with pronounced differences in personal and cultural values, propels change.

## Self-Authorship, Gender, and Race

A growing body of literature that explores the applicability of theory about the development of self-authorship to diverse groups has the potential to add to our understanding of the relevance of self-authorship to women in SET fields. Authors of this scholarship suggest that encounters with marginalizing experiences, such as stereotyping and discrimination, may at times accelerate and at other times retard the development of self-authorship. This section will review studies of self-authorship with regards to racial and ethnic identity and explore the implications of these findings for women in SET.

Pizzolato (2003) examined how exposure to challenging life circumstances influenced the level of self-authorship among high-risk, largely non-white college students. She found that high-risk students displayed self-authoring tendencies at the start of college, likely because their choice to pursue a college education set them apart from their peer group in high school and prompted them to develop an internal sense of self. However, in her follow-up study about high-risk students, Pizzolato (2004) noticed a disturbing trend. The same students that entered college with self-authored views lost confidence because of marginalizing experiences in college and began to follow external formulas once again. Specifically, high-risk students began to doubt themselves when they experienced difficult course work and authority figures that questioned their commitment and capabilities. Some women in SET fields face similar experiences when they are disquieted by encounters with parents, peers, teachers, and/or counselors that express skepticism about their ability and commitment to follow through with the choice of a traditionally male field. Women can benefit from informal activities, such as through an event sponsored by a women in engineering program or club, that provide a safe space for women to exchange information with their female peers about their experiences.

Torres and Baxter Magolda (2004) and Torres and Hernandez (2007) explored the role of self-authorship in identity development in a longitudinal study of Latino/a college students. They found that Latino/a students in the early stages of self-authorship were likely to look primarily to family and friends for information. They were vulnerable to stereotypes because their self-definition came from others. Those who had moved beyond the initial stage of development of self-authorship -- what Baxter Magolda calls "external formulas" -- were better able to understand multiple perspectives and to make conscious choices about how negative stereotypes would influence their self-perceptions.

Abes and Jones' (2004, 2007) studies of lesbian college students shed light on yet another marginalized group and how self-authorship can influence concepts of self. Their goal was to discern what students believed about how their various identities were related. They found that students in more advanced developmental stages were better able to filter outside pressure and to weave together multiple identities, even when they seemed to conflict (e.g., lesbian sexual orientation and socially conservative faith). Much like Pizzolato's discovery, Abes and Jones concluded that lesbians' thinking was more complex as a result of dealing with discrimination and reflecting on their sexual orientation identity. The authors challenged educators to create learning environments that promote identity exploration and complex meaning making. Educators should be cognizant of pervasive campus attitudes about lesbians and other marginalized groups so they may support these students in a meaningful way.

Pizzolato's (2009, in press) research with Asian American students illustrates how the role of the interpersonal dimension and concern for family and community affects decision-making. Her findings downplay the role of autonomy in the decision making of this diverse group of first-generation students. However, her findings nonetheless affirm the importance of an internally created system of beliefs and values for self-authorship. Self-authoring students commit to cultural and religious beliefs for more complex reasons than because they are prescribed by influential others.

Research on high-risk, Latino, Asian American, and lesbian college students reveals important insights about supporting members of underrepresented groups' interest and persistence in SET fields. In these studies, students who were more self-authored were more resistant to marginalizing experiences and gender and racial stereotypes because they had a framework to filter negative messages that erode a sense of self. Thus, complex meaning making will likely allow women to be more resilient in the face of discouragement and more reflective about their ability to achieve success in SET careers without the full support of others.

### **Self-Authorship and SET**

A body of literature is beginning to emerge that directly addresses questions about the application of self-authorship to issues related to women's interest, choice, and success in SET fields. One of these areas focuses on the role of self-authorship in the career decision-making process.

The Women and Information Technology (WIT) team at Virginia Tech designed *The Career Decision Making Survey* (CDMS) with a section about self-authorship to assess what role interactions with others played in high school and college students' interest in a career in information technology (IT). Conclusions from the analysis are somewhat discouraging, in that interactions with others had a statistically significant negative impact on female high school (Meszaros, Lee, & Laughlin, 2007) and college students' interest in IT (Creamer, Lee, & Meszaros, 2007). For both women and men, parents' views about appropriate career choices had a direct, positive, and statistically significant impact on an interest in an IT career. Mothers had a significant positive impact on girls' but not boys' intentions to pursue a career in IT.

WIT team members Creamer and Laughlin (2005) analyzed transcripts from telephone interviews with 119 college women about how open they are to input from others and whose advice they consider in the process of considering career choices. They found that most young women were reluctant to consider career information from sources other than trusted family and friends (Creamer & Laughlin, 2005; Laughlin & Creamer, 2007). "I wouldn't listen" was a frequent reaction to an interview question about how they would respond to a suggestion to consider a career option other than one they had previously considered or selected. This response often reflects the lack of experience in weighing multiple viewpoints that is characteristic of an early step in the journey toward the development of self-authorship. Most young adults are unprepared to navigate and evaluate the diverse and sometimes stereotypical viewpoints they are likely to encounter as they engage others in discussions about career options.

Creamer (2009, in press) later confirmed conclusions she and Laughlin (2005) drew from their analysis of interview data by using responses provided by 186 upper level college students to a section in the CDMS constructed to measure self-authorship. Results confirmed a causal link between self-authorship and action, as more self-authored respondents were in a better position to weigh different viewpoints and to evaluate when a person, like a teacher or advisor, had the credentials and expertise necessary to provide meaningful career advice. They were also less likely to agree with occupational stereotypes or to be immobilized when they found themselves interacting with authorities with very different viewpoints.

Many thought-provoking questions remain about the relationship between self-authorship and interest and persistence in SET majors and career. One important area for future research is to seek further evidence of the link between self-authorship and level of acceptance of occupational, gender, and racial stereotypes. Another promising area for future research is about the relationship between self-authorship and resilience

or the ability to grow intellectually and emotionally despite negative experiences and setbacks. Such research needs to incorporate diverse populations.

### **Self-Authorship Interventions**

The complexity of the self-authorship construct can be daunting to educators wishing to implement strategies to promote self-authorship in their classrooms or programs. Baxter Magolda and King (2004) demystified the process by outlining the Learning Partnerships Model (LPM), a model for developing learning partnerships that can promote self-authorship. Learning partnerships possess elements of support and challenge to meet participants where they are but also provoke them to cross Kegan's evolutionary bridge to a more self-authored phase.

The LPM suggests three principles to follow when designing activities to promote self-authorship: (a) validate learners as knowers, (b) situate learning in learners' experiences, and (c) mutually construct meaning. The LPM is grounded in three core assumptions: (a) knowledge is complex and socially constructed, (b) identity influences knowledge construction, and (c) knowledge is mutually constructed through shared expertise. Baxter Magolda and King (2004) urged educators to apply these principles and assumptions to create a balance of challenge and support to help guide students to be more reflective and think more complexly about their experiences.

Mentoring is a central component of many gender equity programs (Dyer, 2004) because research has consistently shown that it can be effective in increasing girls' engagement in math, science, and technology. Mentoring programs vary widely in their format and their efficacy. For example, traditional mentoring programs, like the one described by Ferreira (2002), depict mentoring as a one-way flow of knowledge from the mentor, or expert, to the student, or learner. In these programs, girls are taught to look to authorities who will impart knowledge about careers in science, so the girls are observers rather than participants in their own learning. This goes against the principles and assumptions that Baxter Magolda and King suggest are crucial to creating a learning partnership to promote self-authorship. An LPM approach to mentoring would strive to develop partnerships, which have the potential to enhance girls' self-authorship development and their investment in SET careers.

Innovative mentoring strategies can be constructed using the principles of LPM. These would be characterized by mutuality and a jointly negotiated agenda between the mentor and mentee. This may involve the girls doing online research about famous women in science, participating in hands-on workshops and career day activities, or taking field trips to visit professionals at their jobs sites (Gavin & Reis, 2003). Getting girls involved in SET-related mentoring activities connects to the LPM's principle of validating their capacity to know and its assumption of portraying knowledge as complex and socially constructed.

The co-construction of an agenda or goals by both a mentor and mentee aligns with LPM's principle of learning by mutually constructing meaning and its assumption of shared expertise. For example, in the EX.I.T.E. (EXploring Interests in Technology and Engineering) program, a collaboration between Colchester Middle School in Vermont and IBM, girls learned project management skills from IBM professionals and evolved from requiring instruction from their mentors about the project to facilitating the project themselves using their mentors only as consultants (Norstrom, Smith, & Haglund, 2008). This program also enhanced the mentoring relationship by using an online communication site called MentorPlace to facilitate mentor-mentee collaboration.

A third attribute of successful learning partnerships is that it is tailored to reach students at their current level of skill and interest and motivate them to develop further. This idea ties in to Kegan's concept of building an evolutionary bridge, the LPM principle of situating learning in the learner's experience, and the LPM assumption that self is central to knowledge construction. An example of targeting mentoring to students' current level of understanding is the "Girls in Science" program between Roosevelt Middle School and the San Diego Zoo (McLaughlin, 2005). Girls in this program met with scientists at the zoo regularly and were challenged to reflect in a meaningful way on the careers they learned about and how well those careers fit with their skills and interests. Similarly, cascading programs like the one described in Reis and Graham (2005) involve multiple levels of mentoring, in this case teachers mentored high school girls who in turn mentored elementary school girls. At each level of these programs, mentors must tailor their efforts for their mentees. In the Reis and Graham example, high school girls researched SET-related activities that would engage their elementary school mentees in the idea that girls can do science and science can be fun.

These examples of mentoring activities illustrate several important strategies that SET educators can use to promote self-authorship in students. Specifically, students should be asked to:

- Engage in conversations and activities with diverse others.
- Play an active role in designing the experience.
- Devote time to reflection about the experience.
- Identify personal skills, values, and interests.
- Practice weighing alternatives to make informed choices.

### **Assessment of Self-Authorship**

One of the biggest challenges for educators and scholars alike is how to measure an individual's level of self-authorship. Until recently, virtually all scholars used semi-structured interviews to assess self-authorship. In the past few years, several scholars have attempted to develop a quantitative instrument to measure this complex construct. In this section, we will highlight both qualitative and quantitative research aimed at capturing an accurate assessment of a student's level of self-authorship.

Kegan (1982; 1994) and others developed a qualitative measure of adult meaning making or "order of consciousness" using the Subject-Object Interview (SOI), which identifies the principles an individual uses to construct their understanding of their experiences (Lahey et al., 1988). Baxter Magolda and King (2007) produced a conversation guide to assist educators in using interviews to encourage the kind of reflection that promotes self-authorship. Baxter Magolda and King explained that constructivist-developmental interviews are most successful at eliciting meaning making when they form a learning partnership and follow a few guidelines. First, interviewers establish rapport with the students and let the students choose the content of the conversation. Second, interviewers encourage students to reflect more deeply on their experiences and give students the time and space to construct their thoughts in the moment. Finally, interviewers ask questions that elucidate how the students made meaning of their experience and why certain experiences prompted students to begin thinking in a more self-authored way.

Some researchers have turned their attention toward designing a quantitative instrument in an effort to find a reliable measure of self-authorship that is less time-consuming to conduct and evaluate than the interview. The central challenge is to design survey questions that capture underlying reasoning accurately and that measure the range of expressions of this complex construct. Pizzolato (2007), Creamer (2009), in

press), and Creamer, Yue, and Baxter Magolda (manuscript under review) have developed preliminary quantitative instruments with promising results.

Pizzolato (2007) developed a questionnaire and open-ended essay that used together are intended to reveal information about a student's self-authoring beliefs and ability to act on them. The Self-Authorship Survey (SAS) is a short questionnaire composed of 24 Likert-style questions (e.g., responses where they evaluate how much they agree or disagree). The Experience Survey (ES), invites the same respondent to write a short narrative describing an important decision they have made. Scores from the two measures were only moderately correlated, an indication that self-authorship is situational. Students that are capable of self-authored thinking may not necessarily act in a way that is congruent with that thinking in all settings. This would be the case, for example, when a bi-racial student is selective in choosing the situations where he or she feels it is safe to disclose their cultural roots.

A second quantitative measure of self-authorship appears in one section of *The Career Decision Making Survey (CDMS)*. Eighteen questions from the section called "Diverse Viewpoints in Decision Making" produced a quantitative measure of the early stages of self-authorship development with moderate reliability (Creamer, 2009, in press; Creamer et al., manuscript under review; Yue, Creamer, & Wolfe, 2009). Results are promising in that they confirm a three stage, three dimension factor structure (Yue et al., 2009) and demonstrate a causal link between meaning making and how students use career information from various sources in the process of career choice (Creamer, 2009, in press). Further research with the measure using diverse populations is needed. However, with additional revisions, the measure of self-authorship from the CDMS has the potential to assess the outcomes of initiatives designed to promote self-authorship, particularly when they involve career choice and decision making.

## Conclusions and Recommendations

Many young men and women begin to explore career options and make decisions about future career options during middle school. From that period on, they make choices about what math and science courses to complete and whether to participate in SET-related out-of-class activities that have long-term consequences on the preparation to pursue most SET majors. The following recommendations involving different aspects of self-authorship are directed toward an audience of parents, teachers, counselors or advisors, and other professionals who have the potential to make a significant impact on the recruitment, retention, and success of women in SET majors and careers. The recommendations are focused on in- and out-of-class activities that promote reflection about values and beliefs.

1. Have young women collect media depictions of women in various careers to deconstruct occupational stereotypes about sex- and race-appropriate career choices and family roles. Offer opportunities to role play or model different ways to respond to stereotypical statements.
2. Prepare young women to make complex decisions by developing criteria to evaluate the credibility of different sources of career information and consider who has the credentials and experience to provide accurate information about nontraditional fields.
3. Create after school programs to educate parents, particularly mothers, about career options in SET and provide them with concrete examples about the roles they can play in promoting informed career decision making by their children.
4. Focus K-12 outreach efforts on students' self-assessment of their skills, abilities, and values and how these mesh with career options in SET fields. Make unfamiliar career choices more comfortable to students by helping them access one of many Internet sites that provide biographies and personal profiles of women in scientific and engineering fields. See, for example:

<http://www.ncwit.org/resources.res.interview.php> or <http://aites5.org/>

5. Promote self-efficacy by sharing information available through WEPAN (Women in Engineering ProActive Network), ASEE (American Society for Engineering Education), and other professional associations that demonstrate women do not have inferior math skills or perform worse than men in SET related courses.

6. Promote involvement in informal and formal out-of-class activities that are "hands-on" and SET-related, including through summer camps, after school activities, service-learning, and internships.

Educational and work-place environments put extra demands on women and members of other underrepresented groups. Baxter Magolda and King's (2004) work to promote learning partnerships makes it clear that effort needs to be directed toward the educational and familial environments that, regardless of how well meaning, prolong dependence on authority and shield individuals from making decisions about important and complex issues. This review argues that it is not the inadequacy of women, but the limitations of educational environments that allow only a few hyper-motivated, tenacious, and superbly capable women to persist in SET fields.

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