POSSIBLE SCIENCE SELVES: INFORMAL LEARNING AND THE CAREER INTEREST DEVELOPMENT PROCESS

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ABSTRACT

This research examines the relationship between career related self-concept and dimensions of informal learning of science. The overlapping dimensions of career interest development and informal learning suggest that self-directed informal learning of science can advance individual self-concept for *possible scientific self*. Possible selves and future scientific selves theories are presented as a perspective for understanding career related aspirations, goals, and fear. In this preliminary research the author seeks to examine the possible role that informal science learning may play in students' sense of scientific self by examining connections between wanting to work in science and dimensions of informal learning and career interest development. Findings from a pilot study of future science selves among n = 63 students in grade 8 are discussed. Additional research is planned among students groups who visit a laser interferometer gravitational wave observatory (LIGO) with hand-on science exploratorium in the Southwest region of the United States.

KEYWORDS

Possible selves, future scientific selves, the career interest development process, informal learning, school science

1. INTRODUCTION

The Government Accountability Office (GAO) of the United States reported in 2010 that approximately three billion federal dollars were spent on science, technology, engineering, and mathematics (STEM) education programs (GAO, 2012). However, research has yet to identify a set of best practices that will increase students' participation in STEM professions (Nixon, Meikle, & Borman, 2013). The informal-to-formal learning of science is thought to be key to encouraging participation in science-related careers (Osborne & Dillon, 2007). Possible selves are recognized as a gauge of career-related self-perceptions. For the manifestation of possible science selves, informal learning and general possible selves within the career development process share dimensions of self-motivation, as well as social and cultural contexts. The shared dimensions of informal learning and possible selves would suggest that the self-directed informal learning of science would advance individual self-concepts for the development of possible scientific selves and lead to increased interest in participation in science-related professions. This pilot study and the larger study that is introduced in this paper will examine the potential role of informal science learning experience in the development of students' sense of scientific self.

2. CONCEPTUAL RATIONALE

Many of the dimensions of informal learning have counterparts within the theories of career interest development, warranting an examination of the connection between informal learning and career interest development. Rennie, Feher, Dierking, and Falk (2003) examined the National Association for Research in Science Teaching (NARST) 1999 committee policy statements on informal science education to present key facets of informal learning that can guide research. These research domains include: 1) self-motivated dynamics, 2) situational contexts, 3) sociocultural facets, 4) cumulative nature, and 5) cognitive components.

Career interest development for self-concept has overlapping dimensions with the five key facets of informal learning presented by NARST. It is, by nature, self-motivated within the maturation process as self-image comes to define *who* an individual is and *what* that person would like to become (Erikson, 1950).

Career learning experiences are authentically situated in apprenticeships, mentoring, and explorations. Career self-concept is influenced by personal experience in social, cultural, and cognitive realms (Merolla & Serpe, 2013). Finally, career awareness, interest, and self-concept are dynamic and cumulative in nature (Ginzberg, 1972).

2.1 Learning and Career Interest

All learning, including informal learning, is a cumulative process involving learning experiences and various reinforcements that take place over time (Rennie et al., 2003). Learning and career awareness are strongly mediated by social interaction, conversation, and experience (Rennie et al., 2003) in a process of socio-cognitive development. Ginzberg (1972) defined occupational choice theory during his extensive study of vocational theories in the 1950s as consisting of three developmental periods: fantasy (before age 11), tentative (between ages 11 and 17), and realistic (between age 17 and young adulthood). Within occupational choice theory, career choice awareness develops through exploration, role-play, and experience in real-world contexts. The fantasy years are important to the career interest development process because students are most receptive to possible career options during this phase. The subsequent tentative and realistic phases are associated with a narrowing of career interest. This narrowing of career interest may be the same phenomenon that is depicted as a developmental loss of possible selves by Oyserman and Fryberg (2006). Urajnik, Garg, Kauppi, and Lewko (2007) recognized that experiential influences of context and experience, beyond the personal characteristics of adolescents, can be models for the prediction of scientific career choice.

2.2 Possible Scientific Self

Possible selves—self-images of current identity and future personas (Erikson, 1950)— can provide a measure of self-concept for career interest. Possible selves are examples of mental components of adolescent development that support the solidification of person and formation of occupational identity (Super, 1980). Within Markus and Nurius' (1986) possible selves theory, career interest can be viewed as an expression of self-perceptions and self-conceptualized selves. Based on psychological theories advanced by William James during the years 1890-1950, possible selves can be viewed as the images of self that are desired, hoped for, or feared (Oyserman & Fryberg, 2006). These images of self are thought to work together to motivate behavior (Shepard & Marshall, 1999). Possible future science selves (Packard & Nguyen, 2003) may prove to assist in understanding science-related career interests during the career interest development process. As future self-views, possible science selves are yet to be verified within a social context and are therefore thought to be impressionable to change and influenced by environment (Markus & Nurius, 1986).

3. MODES OF INQUIRY

This pilot study of relationships between aspects of science career-related self-concept was based on a quasi-experimental design for collection of quantitative data. The search design was limited by constraints of social science research within a public school. Data analysis was conducted recognizing that consideration must be given to confounding extraneous variables that can jeopardize internal validity with quasi-experimental design. Data analysis did not focus on the identification of causal relationships due to possible influence of extraneous variables, such as "history, maturation, testing, instrumentation, regression, or selection" (Campbell & Stanley, 1963, p. 8) that would restrict the validity of claims for cause and effect.

4. DATA SOURCES

Data for this pilot study was originally collected in the fall of 2013 for a study seeking to identify predictors of STEM career interest among middle school students (Mills, 2014). Participants were 8th grade students from two schools in the same school district. These participants consisted of 30 boys and 33 girls. Some

students, 45 of the 63, had been selected by lottery to attend a STEM magnet high school the following school year.

Future science selves were gauged with new subscales of the Career Interest Questionnaire, (CIQ), (Bowdich, 2009). The CIQ subscales gauged perceptions for future scientific selves, the attitudes of parents/society to scientific work, and perceptions of the work of scientists. These subscales have internal consistency and acceptable to very good reliabilities, as interpreted by DeVellis (1991), for the subjects of this study. See Table 1.

Table 1. Career Interest Questionnaire (CIQ) Subscales

Scale/Subscale	**Item Number**	**Cronbach's Alpha** (Interpreted by DeVellis)
CIQ/ Future scientific self	5,6,7,8	.91 Very good
CIQ/ Attitudes of parents/society	2,4,9	.80 Very good
CIQ/ Perceptions of the work of scientists	3,10,11	.70 Respectable
CIQ "I would like to have a career in science" single item.	1	-

The SSS subscales were analyzed for students' preferences for science, technology, engineering, and mathematics.

The following research questions were examined:

- Research Question #1 will be the following statement: "*I would like to have a career in science."* be significantly related to the following:
  - Future scientific self (CIQ)
  - Attitudes of parents and society (CIQ)
  - Perceptions of the work of scientists (CIQ)
  - Attitude towards science, technology, engineering, or mathematics (Stem Semantic Survey (SSS), (Tyler-Wood, Knezek, & Christensen, 2010))
- Research Question #2: Will student's *future scientific self* differ by gender?
- Research Question #3: Will eighth grade students who have been selected by lottery to attend a STEM high school have a significantly different perception of self-concept for *future scientific self*?

5. PRELIMINARY FINDINGS

Preliminary findings for the three research questions are as follows:

- Research Question #1. Bivariate correlation analysis was examined for trends between the statement "*I would like to have a career in science."* and the following CIQ subscales:
  - Future scientific self (CIQ), a significant correlation was identified ($r = .732$, $p < 000$)
  - Attitudes of parents and society (CIQ) was significantly and positively related to the desire to have a scientific career ($r = .692$, $p < 000$)
  - Perceptions of the work of scientists (CIQ) was significantly and positively related to the desire to have a scientific career ($r = .705$, $p < 000$)
  - Only attitude towards science was significantly and positively related to the desire to have a career in science, ($r = .277$, $p = 028$)
- Research Question #2. Analysis of variance revealed no significant difference in perceptions of CIQ future scientific self by gender. Eighth grade boys were found to have a mean response of 3.48, while girls had a mean response of 3.59 (ascending scale of 1 to 5) of CIQ future scientific self.
- Research Question #3. Analysis of variance did not reveal a significant difference in perceptions of CIQ future scientific self between students selected by application/lottery to attend a STEM magnet high school. Students selected for the STEM school were found to have a mean response of 3.59, while students who would attend regular neighborhood schools had a mean response of 3.39 (ascending scale of 1 to 5) on the CIQ subscale, future scientific self. The only significant difference measured was for perceptions of the work of scientists ($p = 0.41$) subscale. Students who applied and were selected by lottery for the STEM magnet school were more positive regarding personal enjoyment and the social

value of doing scientific work, with a mean response of 3.93; while students bound for regular neighborhood schools had a mean response of 3.46 (on an ascending scale of 1 to 5).

These early findings indicate that the desire to have a future scientific career is strongly related to socially and culturally mediated factors that are associated with informal learning and the career interest development process. It is interesting to note that the girls in this study did not differ significantly from the boys.

6. SIGNIFICANCE AND FUTURE RESEARCH

Informal learning is self-motivated, voluntary, and driven by choice and interests—such learning is dependent on authentic contexts and physical setting (Rennie et al., 2003). The career interest development process and career-related self-concept share dimensions with informal learning. An understanding of scientific self-concept and informal learning experiences may prove to be important to efforts aimed at increasing interest in the learning and liking of science and subsequent participation in science-related careers. For example, scientific stereotypes, thought to result from gender socialization, affect the career aspirations of adolescents. "If the caricature of the scientific personality and lifestyle does not mesh with the student's interests, beliefs, and values, she or he is unlikely to become committed to being a scientist" (Etzkowitz, Kemelgor, & Uzzi., 2000, p. 47). Informal science learning opportunities that allow observation of professionals at work can help to dispel stereotypes, which influence career motivation. Informal learning of science may also be key to providing the motivation to stay connected to science as student attitudes towards *school science* decline across the school years (Yager, 1996) while students are thought to maintain separate, more positive attitudes towards real-world science (Osborne, Simon, & Collins, 2003; Ebenezer & Zoller, 1993).

Additional research is planned to examine students' attitudes to informal learning and career interests for future scientific self. The pilot study presented here indicates that there are shared dimensions of career interest development, such as possible science selves, and informal learning experiences. A broader study is underway that will examine pre-post data from participants who visit a laser interferometer gravitational wave observatory (LIGO) that houses an education center with hands-on science exploratorium at an experimental physics research facility. Effects of the LIGO informal science learning experience on future scientific self will be examined.

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