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3. ADOLESCENTS' SCIENCE CAREER ASPIRATIONS EXPLORED THROUGH IDENTITY AND POSSIBLE SELVES

Choosing life and work pathways is a major developmental task for adolescents and young adults. In today's global information age, there is increasing importance placed on training in what has been termed the SMT disciplines—science, mathematics, and technology, where technology includes computer science and engineering. However, increasing, or even maintaining, enrolments in SMT-related courses and degrees at the senior secondary and postsecondary levels has continued to be a challenge (Lyons, 2006; Tilleczek & Lewco, 2001; Tytler, Symington, & Smith, 2009) Women and visible-minority students are particularly underrepresented in these disciplines (Hsu, Roth, Marshall, & Guenette, 2009; Mayer-Smith, Pedretti, & Woodrow, 2000). Educators and employers are calling for educational policies and practices that will help attract and retain more students in these areas.

Our research, conducted as part of the Pacific CRYSTAL Project, has focused on the career planning process, identity, and experiential learning of secondary school science students. Grounded in Social Cognitive Career Theory (SCCT) (Lent, Brown, & Hackett, 1996; 2000; Lent, Hackett, & Brown, 1999), our qualitative, longitudinal study has utilized the cognitive construct of *Possible Selves* (Markus & Nurius, 1986) as part of an in-depth exploration of adolescents' science-related identity and career goals. In this chapter, we describe our research with secondary school science students as well as the outcomes and implications for students, teachers, policy makers, and researchers. From the results of this research, our team has developed several Possible Selves exercises and tools that offer students concrete and engaging means to explore their work and educational aspirations as well as to assist them with decision making in this important planning process.

REVIEW OF SELECTED LITERATURE

Adolescent Career Choice Process

Making career and life decisions in secondary school is both an exciting and challenging experience for adolescents (Code, Bernes, Gunn, & Bardick, 2006; Turner & Lapan, 2002). On the one hand, young people express optimism with regard to their futures and have dreams of rewarding and fulfilling careers and of making

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a difference in the world. On the other hand, the pressure to make career decisions, coupled with potential repercussions in the future, makes these decisions difficult for many students. Code and colleagues (2006) examined sources of adolescents' perceived discouragement about future career goals. They found that senior secondary students felt time was running out and that they were unprepared to make a decision of this magnitude. Their data revealed five main themes: concerns about training and education, overall security issues, levels of satisfaction, fear of failure, and anxiety related to career commitment.

Multiple factors contribute to successful career path development and decision making when transitioning from school to work or from school to postsecondary education (Bandura, 1993; Burkham, Lee, & Smerdon, 1997). One important factor in this process is the adolescent's self-concept. Research has shown that career development is related to a particular aspect of self concept that Bandura and others have termed *self-efficacy*; those students who feel more competent in a particular domain are more likely to engage in relevant career planning and decision-making activities (Bandura, 1993; Turner & Lapan, 2002; Wallace-Broscious, Serafica, & Osipow, 1994). Bandura (1997) discussed the growth of self-efficacy through adolescence and noted that "self-efficacy development can play a key role in setting the course" of the life paths (p. 177). He further asserted that "the task of choosing what lifeworks to pursue ... looms large during adolescence" (p. 184). In spite of the significance of youths' experiences, most examinations of self-efficacy, interest, and career choice have focused on college-age participants (Bieschke, 1991; Mau, 2003; Rottinghaus, Larson, & Borgen, 2003). It is long before their admission to postsecondary institutions, however, that students make important choices in secondary school that determine their options for postsecondary study. The confidence to explore the self in relation to the occupational world, to find educational and work-specific information, and to engage in self-directed vocational planning serves to facilitate successful adolescent career development and the achievement of aspirations.

Several authors have identified various methods of enhancing adolescents' career self-concept and increasing self-efficacy (Bandura, 1993; Cross & Markus, 1991; Mau, 2003; Wallace-Broscious et al., 1994), including participation in experiential learning opportunities (Bandura, 1993; Luzzo, Hasper, Albert, Bibby, & Martinelli, 1999). Experiential learning is defined as the process of actively engaging in an authentic experience, making discoveries, and experimenting with knowledge instead of simply hearing or reading about it from others (Kraft & Sakofs, 1988). In addition to increasing knowledge (Burkham et al., 1997; Powell & Wells, 2002; Tyler-Wood, Mortenson, Putney, & Cass, 2000) and promoting a deeper understanding of learning (Burkham et al., 1997), experiential learning has been found to facilitate career and educational decision making (Burkham et al., 1997; Martinez, 1992; Seymour, Hunter, Laursen, & Deantoni, 2004). Questions arise, however, regarding how these processes work in different fields of study (e.g., science versus arts disciplines).

Luzzo et al. (1999) found a significant relationship between mathematics and science self-efficacy measures and career choice interests and actions. Burkham et al.

(1997) found that students' lack of exposure to science can result in diminished knowledge and commitment to science. Classroom activities, promotion of interest in science, and encouragement of advanced study are important precursors to pursuing further science education and choosing science for a career. Martinez (1992) similarly found that the appeal of science experiments in school may be related to attitudes and future decisions regarding study and career choices. The more prolonged exposure to the culture of science that is part of internships, co-op courses, and other experiential learning opportunities has been shown to enhance students' knowledge and skills in SMT subjects (Neville, 2008). As Correl (2004) pointed out, young people must have knowledge of a given career in order to develop aspirations toward it.

Social Cognitive Career Theory

Anchored in Bandura's (1986) general social cognitive theory, SCCT (Lent et al., 1996, 2000; Lent et al., 1999) is a social interaction view of career development that embraces constructivist assumptions about peoples' capacity to influence their development and surroundings (Mahoney & Patterson, 1992). SCCT focuses on several agentic or self-action variables and how these variables interact with environmental variables, such as social support and barriers in the context of career development (Lent et al., 1999). Three variables from Bandura's social cognitive theory—self-efficacy, outcome expectations, and personal goals—are the basic building blocks of career development and the central theoretical constructs of SCCT. Self-efficacy refers to people's beliefs about their capabilities (Bandura, 1986; Lent et al., 1996). It is not unitary, fixed, or decontexualized but is rather a dynamic set of self-beliefs, specific to particular contexts, that interact in a complex manner with other social, behavioural, and environmental factors. These beliefs are acquired and adapted through four main sources of information: personal performance accomplishments, vicarious learning, social persuasion, and physiological states and reactions. The most robust source of self-efficacy beliefs is personal mastery experience; failure experiences tend to diminish self-efficacy.

Outcome expectations are the second key variable in SCCT. They involve personal beliefs about and the imagined consequences of performing given behaviours. Outcome expectations include beliefs about extrinsic reinforcement, self-directed consequences, and outcomes derived from the process of performing a given activity (Lent et al., 1996).

The third key variable, goals, refers to people's determination to engage in a given activity or achieve specific objectives. Goal-setting is a critical mechanism through which people exercise personal control or agency. Goals help people organize, guide, sustain, and change their own behaviour.

General social cognitive theory posits a complex interplay between goals, self-efficacy, and outcome expectation. Goals are assumed to influence the development of self-efficacy while self-efficacy and outcome expectations, in turn, affect the goals that one selects and the effort expended in their pursuit (Bandura, 1986). However, these social cognitive variables do not arise in a vacuum, nor do they function alone in

shaping vocational interests. SCCT is concerned with several other important personal and contextual influences (e.g., gender, race/ethnicity, family context, genetic endowment, physical health/disability, place, and socioeconomic status) and variables related to social cognitive processes and to the career development process (Lent et al., 1996). SCCT is particularly well-suited to this study's focus—the meaning-making and decision-making processes of young people in career planning.

Possible Selves

In a social–cognitive framework, self-knowledge becomes a key factor in one's ability to reflect on future directions while considering individual context. Markus and Nurius (1986) described one domain of self-knowledge as possible selves. These possible selves constitute a personalized form of self-concept that represents the hopes, dreams, and fears that individuals have had in the past and currently as well as those aspects of their selves in future. An individual's set of hoped-for, feared, and expected possible selves can be understood as "the cognitive manifestations of enduring goals, aspirations, motives, fears and threats ... [and can] provide the specific self-relevant form, meaning, organization, and direction to these dynamics" (Markus & Nurius, p. 954). They contend that self-knowledge or possible selves become important motivators to select future behaviours. Such selves are derived from a number of salient factors, including sociocultural and historical context, media influences, and social experiences. The construct of possible selves is particularly relevant to life and career development because people's work and educational aspirations are significantly influenced not only by personal variables but also by their social environmental context.

Several researchers have applied the concept of possible selves in exploring factors related to life and work choices (Cross & Markus, 1991; Fisher, 2010; Marshall, 2002; Marshall & Guenette, 2008b; Shepard & Marshall, 1999; Wai-Ling Packard & Nguyen, 2003). Lee and Oyserman (2007) suggested that, in order for possible selves to have an impact on outcomes, they must be "cued in relevant contexts, linked to strategies, and balanced, that is, include both possible selves to work toward and feared selves to strive away from" (p. 40). The feared self plays a particularly important role; it motivates individuals to partake in actions capable of preventing its occurrence in the future. It has been found that in considering hoped-for selves young people are able to identify actions necessary for avoiding feared selves (Shepard & Marshall, 1999). By exploring their possible selves, students become active participants in a meaning-making process that illuminates their hopes and fears for the future as well as specific concrete steps they are and can be taking to work toward their aspirations.

In the present study, possible selves mapping techniques were incorporated into semistructured interviews with adolescents to identify factors influencing career decision making and school-to-work transitions for adolescents interested in science-related fields. The research questions for the study were:

- How do secondary students describe their science identity and career aspirations?
- How do these students' self-views and aspirations change over time?

METHODOLOGY

Participants

The initial participants ($N = 13$) in the study at Time 1 were 16–17-year-olds enrolled in a Grade 11 biology career preparation program at an urban secondary school. Ethnic origins of the sample included Arab, Caucasian, East Asian, and South Asian cultures. As part of their career preparation program, students were required to participate in 100 hours of internship activities over 2 years; this included museum trips, assisting in laboratories, field work with naturalists, job shadowing medical practitioners, and other activities. All students participated in a 12-hr internship at a university science laboratory over three to four weeks between interviews at Time 1 and Time 2. As with all longitudinal studies, the sample declined over the 3 years; some participants were not available at interview time, some declined a follow-up interview, some had moved and could not be located. The total student interview sample is shown in Table 1.

Table 1. Total student interview sample

Time	*Period*	*Number of participants*
1	January of Grade 11	13 (11 F and 2 M)
2	May of Grade 11, postlaboratory	11 (9 F and 2 M)
3	May of Grade 12	6 (6 F)
4	August, 1 year post-Grade 12	4 (3 F and 1 M)

As part of the project, the biology career preparation teacher was interviewed at Times 1, 2, and 3; university laboratory researchers and graduate students were interviewed at Time 2. In this chapter, only student interview data are described and discussed. (For additional details regarding other elements of the study, including information on the development and applications of Possible Selves exercises and maps, see Hsu et al., 2009; Marshall & Guenette, 2008a, 2008b; Marshall, 2009; Roth, van Eijk, Hsu, Marshall, & Mazumder, 2009.)

Data Collection Methods

Semistructured interviews. Interviews were video-taped and lasted between 50 to 90 min. An interview guide was developed for each of the four data collection times. All interviews included initial general questions for rapport building (How have things been going? What's happening at school right now?), the Possible Selves Mapping Process (PSMP), and open-ended question prompts (Is there anything you would like to add? What stood out for you today?). Encouragers (mm-hmm. Tell me more about that) and open-ended questions (How did that turn out? What did you do next? Is there anything else to add to this list of hoped-for selves?) were used throughout the interviews to facilitate the conversation. Times 1 and 2 interviews included specific questions regarding the laboratory internship. Time 3 interviews focused more on future plans, including areas other than schooling. In the Time 4 interviews, participants were asked to reflect on the research process over the previous

3.5 years. All interviewers received training in general and PSMP interviewing skills and practiced with each other before interviewing participants.

Possible selves mapping process. The use of creative methods to engage youth participants in research is suggested by a number of researchers (Morrow & Richards, 1996; Punch, 2002). Over several years, our research team has developed and adapted different forms of visual data collection instruments that we have found to be effective in engaging participants (particularly youth) in qualitative interviews (Guenette & Marshall, 2009; Marshall, 2009). As Packard and Conway (2006) observed, "One major advantage of visual methods is that they are sensitive to non-textual, spatial forms of representation and participants are likely to find them a novel and creative form of expression" (p. 261). Based on a paper and pencil instrument (Cross & Markus, 1991), Shepard (1997) initially developed a mapping exercise utilizing the construct of Possible Selves; this exercise has been further revised and extended by our team in several studies (Guenette, Morley, & Marshall, 2007; Marshall, 2002; Marshall & Guenette, 2008b). In addition to the benefits of engagement and ease of construction, we have found that visual representations enable us to understand the complex and interrelated experiences of career development in a manner that would have been difficult to accomplish with self-report instruments or interviews alone. In this study, we utilized the PSMP developed specifically for this research and refined over the course of the project (Marshall & Guenette, 2008a). The 2008 version includes an illustrative DVD and accompanying manual for students and teachers.

The PSMP involves seven steps:

- Creating a Brainstorming Map of hoped-for and feared possible selves
- Grouping and naming these possible selves
- Debriefing the Brainstorm Map
- Identifying most hoped-for feared selves and expected selves
- Transferring brainstorm information to the Possible Selves Map
- "Things to do right now"—actions to achieve hoped-for selves and avoid feared selves
- Reviewing overall impressions, thoughts, and goals

Figure 1. Brainstorming map.

Participants explain their choices and think aloud throughout the process. They use sheets of paper and coloured sticky notes that can be moved around for the Brainstorm Maps (Figure 1). Specific selves are transferred to the Possible Selves Maps (Figure 2), and participants then identify potential actions related to these selves. They are given copies of their maps to take with them for further reflection and as a concrete record of the interview.

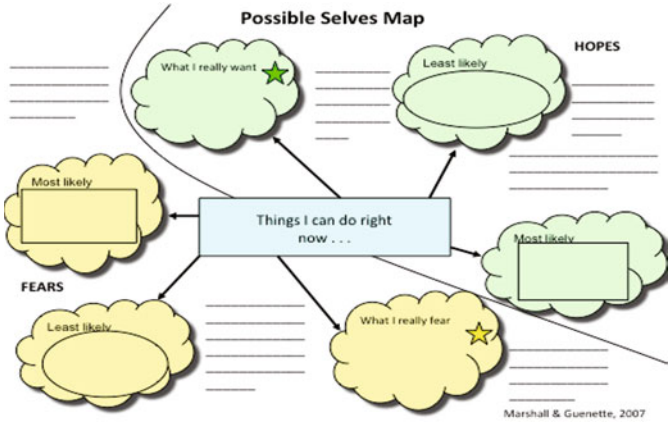

Figure 2. Possible selves map.

Data Collection Procedures

Observations and timeline. The study commenced with 22 hr of videotaped observations in the students' biology and career preparation classes in the fall semester 2006 of Grade 11 in order to gain an understanding of their school program context. Further observations were conducted during the students' university laboratory internship in the spring semester 2007 of Grade 11. As part of our interdisciplinary collaboration within the Pacific CRYSTAL Project, one graduate student utilized these and later observations and interview data as part of her doctoral research on science discourse (Hsu, 2008).

Interview – Time 1 Student participants were interviewed by graduate students in January 2007 of Grade 11, near the end of their first semester in the career preparation program. After initial discussion to provide background regarding career interests and to build rapport, students completed the PSMP. Additional questions focused on their experiences in the career preparation program and thoughts about the upcoming laboratory internship.

Laboratory Internship. In March 2007 of their Grade 11 year.

Interview – Time 2 After the laboratory internship, 11 participants were interviewed again. They were given interview summaries and their maps from Time 1. They completed the PSMP, adding any new hopes and fears, rearranging as needed,

and explaining their choices. The students were asked how the laboratory experience had impacted their career choice and planning process.

Interview – Time 3 At the end of Grade 12 in 2008, 6 of the 11 Time 2 participants were available to be interviewed. After seeing Time 1 and 2 maps and interview summaries, they again completed the PSMP and were asked about their plans and intentions after graduation.

Interview – Time 4 Four students were available to be interviewed 1 year after completing Grade 12 in 2009 (one male had not been interviewed at Time 3).

Data Analysis

Analysis of the interview transcripts and maps was accomplished through multiple readings and iterative reflections on data themes and meanings (Guenette & Marshall, 2009; Marshall, 2009). The following steps were utilized after each round of interviews:

- Review video-taped interviews and make overall impression notes.
- Transcribe the interviews, adding further notes.
- First reading of transcripts, 'chunking' of complete ideas, assign tentative codes.
- First iteration of major data categories and specific content themes within transcripts.
- Read again; revise categories and themes, checking for consistency of coding.
- Highlight and colour-code transcripts by categories and themes; identify quotes.
- Read again; identify more specific subthemes within themes.
- Construct category and theme tables with corresponding quotes.
- Compare categories and themes across participants.

After the Time 4 analysis was completed, a reading across all four interviews was conducted for the four longitudinal participants. Overarching themes and subthemes were identified.

SUMMARY OF RESULTS

In this section, the research questions and data analysis summaries are presented. Tables of main data categories and more specific data content themes are included for each wave of interviews: Times 1 and 2, Time 3, and Time 4. Times 1 and 2 are presented together because the data categories and themes were very similar. Selected highlights from the data are described, with brief illustrative participant quotes *in italics*, due to space limitations.

Research Question for Times 1 and 2: How do Secondary Students describe their Science Identity and Career Aspirations Before and After an Authentic Laboratory Experience?

During Times 1 and 2, more than 50 interviews and observations were conducted with the participants in their classrooms and at the university laboratory. Data categories and themes identified across participants are presented in Table 2; highlights and participant quotes related to several data themes are described next.

Table 2. Interview analysis Times 1 and 2

Data category	*Content theme*
Identity related to career aspirations	Science careers
	Stereotypes about science
	Nonscience careers
	Hoped-for and feared selves
Influences on career decisions	Gender
	Supports and barriers
	Parental and family influences
	Other influences
Planning process	Planning for the future
	Knowledge
	Experiences and behaviours
Learning about science	Stereoypes about science
	Experiential learning

Science careers. Not surprisingly, all participants described specific goals and hoped-for selves in science fields: *Environmental engineer, Doctor, Marine biologist, Health service, Laboratory technician, Nurse.* While expressing an avid interest in biology and science, a few students shared hoped-for and feared selves that were unrelated to science, such as *Photographer, Lawyer, Actor,* and *Teacher*.

Hoped-for and feared selves. Students listed multiple hoped-for and feared selves in relation to future careers in science. Hoped-for selves categories were at times specific, for example, *Health science, Human health service, Medical doctor, Laboratory-work analysis*. At other times, the categories were quite broad, for example, *Involving mathematics, science, biology*. Some of the hoped-for career selves reflected deeply held values such as *A career that describes me, Doing something interesting, Helping the world*. The feared self categories focused on anticipated negative aspects of particular science work such as *Boring, Dangerous, Going nowhere*. Fears also related to issues of commitment: *Long hours away from family and friends, Years of schooling, Student debt.*

Stereotypes about science. When asked what scientists are like, one participant said, *Eccentric ... geeky ... pretty weird ... cooped up in a lab all day with a bunch of pig foetuses is pretty weird*. Other students described rather stereotypical views of scientists: *Absent-minded, Socially awkward, Looking like Albert Einstein*. After the laboratory experience, the students demonstrated a much more realistic and specific understanding of scientists: *It was really cool ... seeing how the scientists and the students worked through their experiments.... Now I know what they do*.

Parental and family influences. Parental and family influences contributed to both hoped-for and feared selves and career paths: *My mom really got me started on biology, My dad talked to me about Doctors without Borders, I watched my relatives who are doctors and that's way too much work—I want to have a life*. Talking with family members about options, as well as about the pros and cons of particular

science jobs, helped these students evaluate possibilities and establish priorities regarding future training and work.

Supports and barriers. The difficulty of making a decision at this stage of life represented a constraint for several students: *It's kind of hard to want to lock into choosing a career for the rest of your life when you're 17.* Students also felt decisions would affect the rest of their lives. *It's almost scary* [thinking about future career plans]. *They're* [decisions for the future] *so important. You can make one wrong move and you can't go back.*

Research Question for Time 3: How do Grade 12 Students describe their Science, Career, and Life Aspirations?

During this wave, follow-up interviews were conducted with 6 of the original 13 participants. Students were able to further reflect on their science career aspirations as they approached graduation. The data categories and content themes identified across the interviews are presented in Table 3, followed by some highlights of the themes from Time 3.

Table 3. Interview analysis Time 3

Data category	*Content theme*
Factors influencing career aspirations	Financial security
	Self efficacy
	Ideals and values
	Social influences
	Contextual influences
Planning process	Goals
	Maximizing success
Relationships	Family
	Balance

The participants were excited about their future options while being more aware near the end of Grade 12 that postsecondary education and the world of work would be more challenging than they had anticipated in Grade 11. There was more recognition that ideas about career and actual career choices could change over a work life. There was an acknowledgement that some of the hoped-for future selves generated at Time 2 were somewhat unrealistic, but these were still held as ideals of a future self. A few of the students regretted not having saved more money over the secondary school years as the real cost of postsecondary education was clearer at the end of Grade 12.

Financial security. As these students neared the end of secondary school, financial considerations appeared to be more salient: *University costs a lot ... I don't want to have money problems.* Some described conflicting thoughts: *I want to have a job that I can make good money at ...* yet *… I don't want to take something just because it will make me a lot of money.*

Ideals and values. Students expressed their high ideals related to future careers mainly in the area of their desire to help others: *I like the helping part, helping people and making them better. I need to feel like, in my career, I am helping ... helping the world would be amazing. I want to count for something, having a big impact on something*.

Goals. During the PSMP part of the interview, participants were able to talk about what actions would help them to achieve their goals: *Well, if I study hard now I will have more choices about where to go for school … maybe I'll get a big scholarship somewhere. I need to get some community type experience before I can apply to medical school.* They did sense the importance of the decisions they were making with regard to their futures: *This is a big deal … I don't want to have any regrets later.* Yet, some were not too worried: *I have time to decide.*

Family. As they matured, the students seemed to put more emphasis on relationships with family and friends than when in Grade 11: *Well. I'll have to see … because I do want to have kids and stuff. I'll need to get a good job so I can support my family.* They also acknowledged the time and commitment required in having a partner and children: *I don't want to work all the time like my mom had to … I want to have time to enjoy things.*

Time 4: How do Beginning Postsecondary Students describe their Career and Life Aspirations?

Four participants were available to be interviewed 1 year after finishing Grade 12. Data categories and themes across participants are presented in Table 4.

A year after finishing secondary school, the participants were more difficult to locate. Only two were in postsecondary programs. Those who were interviewed at

Table 4. Interview analysis Time 4

Data category	*Content theme*
Factors influencing work aspirations	Influences
	Self-efficacy beliefs
	Ideals and values
	Financial security
	Career goals
	Finding meaning
Health and well-being	Happiness
	Self-care
	Healthy lifestyle
	Balance
Relationships	Relationships
	Family
	Peers
	Support

Time 4 described many goals and aspirations that were similar to previous times. Ideals and values, financial security, and finding meaning were still very important. Relationships and well-being were emphasized more strongly. Two new themes were identified and are briefly described.

Self-care. A new theme that was identified at Time 4 was self-care. A couple of participants were feeling pressured by multiple demands: *You know, it just seems like there is never enough time these days … it's tough at times.* One participant had experienced health problems: *I just had to take time to take care of myself. Some of my plans just had to go on hold.*

Peers. Although friends had been mentioned before, participants spoke about the specific support they received from friends: *It's really important to me to have them there, you know … I don't want to lose touch. I never thought I was really a social type but now it seems more important to me*.

Longitudinal Analysis from Time 1 to Time 4. How have Participants' Career and Life Aspirations Stayed the same or Changed Over the 3 Tears of the Study?

A longitudinal thematic analysis was conducted on the transcripts and maps of the four participants interviewed three or more times over the 3 years of the project. To distinguish this overarching longitudinal analysis from the preceding Times 1 to 4 analyses, the data analysis groupings have been called meta-themes and content elements and are presented in Table 5.

Table 5. Longitudinal analysis Times 1 to 4

Metatheme	*Content element*
Consistency over time	Career goals
	Life goals
	Hoped-for and feared selves
Changes in goals over time	Career choices refined
	Greater importance on relationships vs. careers
	Desire for overall happiness – balance
Influences on goals over time	Early career planning
	Experiential learning
	Life circumstances

Consistency over time. Looking back over the course of the study, all participants acknowledged consistency in their goals and possible selves. Upon being shown all her maps, one young woman commented: *Omigod, it's totally the same!* One participant was still committed to a career in environmental science; another had kept her interest in travelling; a third participant maintained her goal of a career in medicine, even though the specific field changed from dermatology to surgery or paediatrics. In terms of life goals, a desire for overall happiness and fulfillment was

also important for everyone: *This whole thing* (map) *could be just "be happy."* A consistent feared-self for all was not being financially secure: *It's funny 'cause a lot of this stuff is the same, pretty much … financial security.*

Changes in goals over time. Not surprisingly, shifts in emphasis were evident from Grade 11 to after graduation. As one young woman commented: *I am starting to go more into life environmental technology … so I have kinda almost branched off.* More than one participant acknowledged putting greater importance on maintaining relationships in both work and family contexts. Looking back, they also recognized a wish for balance in their lives: *I want to have time for both work and a family—not just working all the time.*

The career exploration and planning they did in Grades 10 and 11 encouraged these young men and women to think about what they wanted in their futures and to search out information about several possibilities: *We have been asked a lot of questions about our jobs, career, and stuff … we have done a lot of projects. Yeah, I have pretty much researched all of these* [careers].

Influences on goals over time. Experiential learning opportunities had clearly influenced the extent to which these young scientists could view themselves working in the field. For some students, these hands-on experiences reinforced their interest and commitment to a career; for example, one participant who had decided to become a paediatrician had volunteered in a hospital; another interested in biotechnology had done a co-op placement. For others, they became aware that a particular science career or work setting was not something they wanted to pursue: *I'd figured from that* [laboratory experience] *that I probably didn't want to be in a lab.*

Life circumstances had affected original educational and career plans for some. One young woman had to postpone postsecondary plans because she needed full-time employment to cover her current expenses. Another participant who struggled with a health issue realized that the typically intense course load in first and second year university science programs would be too much to handle at this time. Most commented that they had not thought much about back-up plans if their earlier goals were no longer attainable.

Overall, in looking back, the students could identify and articulate the experiences and influences that had shaped their pathways. Some could see the thematic or disciplinary continuity and links among their choices along the way: *You know, step by step I've been getting closer and closer to what I really want to do.* Others seemed to be moving toward greater diversity and increased options: *I want something that brings me more in contact with people and not the same thing all day. I'm not 100% certain what my end title will be … the more I hear about things … there are things you don't even know about, right … so I don't have to decide right now.*

DISCUSSION

Most of the young people in this study maintained their *science identity* to some degree and their interest in science-related educational and career goals over the

course of the study although their horizons had broadened over the 3 years. This could be expected, given that they had made a commitment in Grade 11 to a fairly demanding and focused biology career preparation program. However, at the end of Grade 12 and 1 year after, not all had enrolled in postsecondary science training or degree programs; and there had been a number of shifts in the interests and plans they had identified and developed in secondary school.

In Grade 12 and after, participants placed greater emphasis on relationships; participants were more aware of the *bigger life picture* and spoke of balance and life satisfaction. Moreover, these young people described a more practical and realistic view when articulating future plans. These findings are consistent with those of many career transition researchers (Burkham et al., 1997; Lent et al., 2000; Turner & Lapan, 2002). The emphasis on having a fulfilling job—one that would make a difference in the world and also pay well—was still prevalent, but a real awareness of the cost involved in postsecondary education slipped into the participants' maps and reflections. Some spoke of needing to be able to find the well-paying job that would make such a financial investment in education worthwhile. As noted by others (Code et al., 2006; Turner & Lapan, 2002), young people have dreams of rewarding and fulfilling careers but also feel concerned about making career decisions that could include potential repercussions in the future.

Similar to Arnett's (2004) research on emerging adults, young people in this study expressed optimism with regard to their futures. At the beginning, they did appear to feel some pressure to make the right choice and expressed some fears related to making a wrong or poor choice. This was similar to Code and colleagues' (2006) participants who felt that time was running out and experienced pressure to make a decision. However, anxiety seemed to decrease somewhat over time for the present participants. As they grew older, there appeared to be less emphasis on getting to the dream job than at the beginning of the study. New learning and life experience were providing more and new ideas, and the prevailing attitude was *I don't have to choose yet*. This shift highlights the importance of encouraging adolescents to remain open to career goal changes and new opportunities since relatively few students end up where they originally expected (Lent et al., 1996).

Experiential learning activities were clearly influential for these young people. Enhanced self-efficacy and increased science knowledge were significant outcomes of the university laboratory internship. This is consistent with research demonstrating the benefits of experiential learning opportunities (Neville, 2008; Roth et al., 2009). Participation in experiential learning opportunities has been found to enhance adolescents' career self-concept and increasing self-efficacy (Bandura, 1997; Luzzo et al., 1999). The experiences in the laboratory and elsewhere provided opportunities for them to engage with and practice science—not only to listen to or watch science. Burkham and colleagues (1997) suggested this promotes a deeper understanding of and better application of learning.

Correl (2004) posited that young people must have knowledge of a given career in order to develop aspirations toward it. Through the university laboratory and other hands-on science experiences, the participants had practical understandings of what some of the tasks of a career in science could include. The adolescents had

the opportunity to explore their educational interests and abilities; previous research (Burkham et al., 1997; Martinez, 1992; Seymour et al., 2004) suggests experiential learning can facilitate career and educational decision-making. Martinez similarly found that the appeal of science experiments in school may be related to attitudes and future decisions regarding study and career choices.

The choice and career developmental processes described by the participants are consistent with the principles posited in SCCT. The students' interviews provided vivid and concrete examples of their self-action variables and how these interacted with and, in turn, were shaped by their environmental and social contexts. The findings provide support for continued emphasis on the central constructs of self-efficacy, expectations, and personal goals (Bandura, 1986) in career exploration and development resources and activities.

Applications

An important aspect of the research has been our commitment to community-based research partnerships with secondary schools and the importance of practical tools and solutions. This commitment has guided the development of a DVD resource and accompanying manual for teachers so they can use the PSMP in their classrooms (Marshall & Guenette, 2008a). These materials provide several individual and group options for middle and secondary school teachers to apply the Possible Selves concepts and techniques to help students explore and act upon their science (and other) career aspirations. Underserved and underrepresented groups should be prime foci for such applications to SMT-related disciplines and careers. Fisher (2010) attempted to use some ideas for Possible Selves to explore aboriginal students' secondary school mathematics experiences and their stories of opportunities and obstacles.

IMPLICATIONS

Research

Longitudinal studies are challenging but extremely valuable for theory and research. Following a group of secondary students over their key school-to-work/education transition years provided rich insight into career–life decision and planning processes. Given both the consistencies and the changes evident in all the participants, it is imperative that early career exploration in secondary school be revisited in order to help students integrate new ideas and experiences and extend their understanding of the potential implications for life and work choices and pathways.

With respect to methodology, the PSMP interviews provided rich and detailed data that we would not have obtained through surveys or even conventional interviews. The PSMP provided participants with a unique opportunity to develop thoughts, ideas, and options before being asked to elaborate on their actual classroom, laboratory internship, and other science-related experiences. The process facilitated engagement in and reflection on current hoped-for and feared future selves as well as on

maps created previously. When participants construct images and explain their meaning, researchers are able to fill in gaps and spark further exploration and refinement of meaning. In the present study, bringing the visual map back to participants provided snapshots in time that facilitated further reflection on hopes, fears, and possible actions. The present investigation, along with Wai-Ling Packard and Nguyen's (2003) study with adolescent girls, appears to be the only research linking Possible Selves to youth science careers; more research is needed in this area.

Career Planning

The present research findings have implications for career education teachers and counsellors as well as for policy developers. The major theme of changes over time highlights the importance of planning and goal setting on young people's career planning. From the beginning of secondary school, counsellors, educators, and parents need to pay particular attention to students' goal-setting and decision-making skills and to assist them to assess the implications of their choices. Most postsecondary science programs for example, have particular prerequisite requirements for secondary mathematics courses. Helping students learn how to set and create steps for large and small goals is critical to successful career planning. Goal setting is also useful for other life issues, not just simply education and work. Demonstrating goal-setting strategies and following up on measurable steps is strongly recommended for counsellors and career educators working with youth or young adults on work–life issues. Our findings also underscore the importance of goal flexibility and having more than one option.

CONCLUDING THOUGHTS AND LESSONS LEARNED

Classroom activities, promotion of interest in science, and encouragement of advanced study are important precursors to choosing science for a career and pursuing further science education; however, they are not sufficient for a significant group of students. The findings from the present study emphasize that mentorship, experiential learning opportunities, and regular decision-oriented activities are critical elements in the career transition process.

Experiential learning opportunities enable students to see science in action: What do scientists do and how do they arrive at their particular work positions? How do you manage a laboratory, look after equipment, work on a team, and achieve goals? The potential of mentorship is underscored by the present research results demonstrating the importance of family influences, relationships, and experiential learning in authentic science setting (see Wright, Claxton, Williams, & Paul, Chapter 4 this book). When interacting with an adult scientist, students are able to observe and understand the connections among education, training, and skill development. Hands-on internships are ideal; however, conducting informational interviews or shadowing people in the workplace are also worthwhile. Preparation for these activities is particularly important, as is reflection afterward on the similarities and differences encountered.

Career exploration and development must include more than jobs and work. Values, relationships, and lifestyle preferences are closely connected to life decisions and satisfaction. The importance of fulfillment and making a difference in the world were strong motivators for several of the youth in the present study.

The skills and processes needed for setting goals, establishing priorities, and making decisions are vital in this time of transition to adulthood. Students should be encouraged to generate multiple plans and options and to be prepared for unexpected events. They are then less likely to feel discouraged or immobilized if their initial plan or preference does not work out.

Exploring science identity and possible selves over time would appear to facilitate adolescents' career transition process. Experiential learning and mentorship opportunities were seen to be particularly influential for enhancing self-efficacy and constructive decision-making skills. Teachers, career educators, counsellors, and parents are important supporters of and contributors to successful career transitions. Science educators in particular have a critical role to play in assisting young people to seek out information, experiences, and mentoring relationships that will help them make informed choices leading to rewarding careers in science.

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