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Participation in Research Apprenticeship Program: Issues Related to Career Choice in STEM

Irit Sasson [1,2,3]

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Abstract Research apprenticeship experiences provide a uniquely authentic context for deepening participants' understanding of the nature of science and encouraging them to choose STEM (Science, Technology, Engineering, and Mathematics) studies and careers. This study evaluated a STEM program for high school students who engaged in science research with the mentoring support of academic and industrial experts. The goals were to explore how graduates perceived the program as a factor affecting their choice to specialize in a STEM career and whether the findings demonstrate gender differences. Using the sequential mixed method, 24 students were interviewed, and then, the findings were used to develop a questionnaire to which 116 program graduates responded. The responses revealed four main themes of contribution: development in science learning, development of self-efficacy, effect on students' choice of specializing in science and technology in the future, and sense of belonging to the residential area. The results indicate a positive correlation between the attitudes of students participating in the program and their expectation to pursue a STEM-related career. Statistically significant differences were found between the attitudes of the young men and women. The study provides a deeper understanding of the gender gaps in science education.

Keywords Gender differences · Research apprenticeship program · Self-efficacy · STEM career

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✉ Irit Sasson
iritsa@telhai.ac.il

[1] Tel-Hai College, 1220800 Qiryat Shemona, Israel

[2] Shamir Research Institute, Katzrin, Israel

[3] University of Haifa, Haifa, Israel

Introduction

The development of human capital and the index of economic growth are linked to education in general and to science education in particular (Barro, 2001; Hanushek & Kimko, 2000). The importance of science education is also salient in light of the recognized social value of scientific and technological applications in medicine, agriculture, communications, and more (DeBoer, 2000; Millar & Osborne, 1998; Toh & Goh, 2003). Despite the great importance attributed to STEM (Science, Technology, Engineering, and Mathematics), science centers and other innovative pedagogical approaches to science education have not been evaluated sufficiently. Little is known about the structure and systematic action required to achieve desired educational outcomes.

Science centers are an example of an informal learning environment. Informal learning occurs outside the school environment and is characterized by voluntary participation and the lack of traditional score-based assessment (Crane, Nicholson, Chen & Bitgood, 1994; Hofstein & Rosenfeld, 1996). Science centers provide valuable motivating opportunities for learning science. Such enrichment activities are perceived as an opportunity to increase student interest in science, but their effectiveness remains unclear (Sasson, 2014). The duration of the science intervention program is one factor affecting results (Bozdoğan & Yalçın, 2009; Jarvis & Pell, 2002).

Positive attitudes toward science are believed to be very important for encouraging students to continue science studies and choose careers in the field (Cavallo & Laubach, 2001; Jarvis & Pell, 2005), and in enhancing achievement in science (Osborne, Simon & Collins, 2003). Studies have reported a range of gains in cognitive learning and positive science-related attitudes as outcomes of participating in science enrichment activities, but the findings for cognitive and affective changes are not always consistent (Anderson, Lucas, Ginns & Dierking, 2000; Falk, Scott, Dierking, Rennie & Cohen, 2004; Jarvis & Pell, 2005; Pedretti, 2002; Rennie & McLafferty, 1995; Simon, Johnson, Cavellt & Parsons, 2011).

According to Anderson et al. (2000) and Jarvis and Pell (2005), meaningful learning processes during out-of-school experiences are influenced by pre-visit, in-visit, and post-visit activities. Falk and Dierking (1992) suggested that the visit experience depends on interaction among three contexts: (a) the visitors' own personal backgrounds of knowledge, experiences, skills, motivations, and desires; (b) the social interactions during the visit; and (c) the physical environment created by the center surroundings. Price and Hein (1991) defined educationally effective programs as those "in which products are not emphasized, inquiry is sparked, open-ended questions are generated, and students actively participate and appear involved" (p. 510).

This research examined a STEM enrichment program in which 11th and 12th grade students conduct science research projects with the mentoring support of academic and industrial experts. The program takes place at a science center. Each program session lasts for about one and a half years and includes regular, bi-weekly meetings between students and a personal mentor who accompanies the student in a complete, authentic scientific process. At the beginning of the program, the students submit a research proposal to the Ministry of Education for approval. At the end of the process, their written research work is examined by Ministry of Education officials and the students receive points of recognition on their matriculation certificate.

The STEM project was designed based on the assumption that apprenticeship experiences grounded in academia and industry mentoring will provide the support needed for students to conduct high-level science projects that will improve their research skills, self-efficacy, and attitudes toward STEM. In turn, these achievements will increase their accessibility to higher education in STEM studies and their integration into this employment sector. The goal of this study was to investigate how graduates perceive the project as a factor affecting their choice to specialize in a STEM career.

Research Apprenticeships as an Influence on STEM Career Choice

Many years ago, before the operation of schools as we know them today, learning by apprenticeship was the most common means of learning (Lave & Wenger, 1991). Recent science education reform documents indicate that participating in scientific inquiry has the potential to influence learners' conceptions of the nature of science (National Research Council [NRC], 2007, 2012). Research apprenticeship offers a uniquely authentic context for maximizing that potential. Authentic refers to the nature, timing, and site of the science activities. Student apprentices work in a university/college or engineering laboratory and receive mentoring during an authentic investigation (Burgin & Sadler, 2016). Apprenticeship situates the science investigation in the context of the particular scientist's research agenda, serving the vested interests of both scientist and apprentice (Barab & Hay, 2001). Collins, Brown, and Newman (1989) suggested four stages in the apprenticeship process: (1) developing of learning contexts, (2) providing coaching and scaffolding as students engage in authentic activities, (3) gradual removal of scaffolding as students develop competence, and (4) providing opportunity for independent practice. "Apprentices learn to think, argue, act, and interact in increasingly knowledgeable ways, with people who do something well, by doing it with them as legitimate, peripheral participants" (Lave, 1997, p. 19).

As such, research apprenticeships have strong potential to impact high school students' science practices, understanding, motivation, self-efficacy, and career choice (Bencze & Bowen, 2009; Sadler, Burgin, McKinney & Ponjuan, 2010). This learning method enables modeling, coaching, and inquiry (Collins, Brown & Holum, 1991; Feldman, Divoll & Rogan-Klyve, 2013). Sadler et al. (2010) reviewed 53 studies of scientific research apprenticeship experiences for high school students, undergraduates, and teachers and found that promoting interest in the sciences and career aspirations was the most frequently reported variable across the studies reviewed. This finding is important given that an individual's interest that is strongly linked to intrinsic motivation is the most meaningful psychological variable for career decisions (Hidi & Renninger, 2006; Krapp & Prenzel, 2011; Linnenbrink & Pintrich, 2002; Ryan & Deci, 2000). It is also important given that experiences during high school were found to influence career choices in STEM. In particular, participation in out-of-school science programs (informal learning activities) was found to be related to student interest in a STEM career (Dabney, Tai, Almarode, Miller-Friedmann, Sonnert & Sadler, 2012).

Behaviors at the stage of choosing a career result from the interaction of personal and contextual variables. Three social cognitive mechanisms are relevant to career choice: self-efficacy, outcome expectations, and goal representations. Self-efficacy refers to people's belief and confidence in their ability to understand or to do well, to meet challenges, and to perform to the best of their ability (Bandura, 1986; Martin, 2001; Zimmerman, 2000). Individuals tend to choose a career in which they will be able to succeed; therefore, self-related cognition is an important factor influencing career choices (Marsh & Yeung, 1997; Staff, Messersmith & Steinberg, 2009). Outcome expectations include monetary support, social approval, and self-satisfaction (Bandura, 1986). Goals such as career plans, decisions, and aspirations have an important role in motivating behavior (Lent, Brown & Hackett, 1994). Two additional sets of variables influence career-related interests and choice behavior: physical attributes (e.g. gender and race) and environmental features and particular learning experiences (Lent, Brown & Hackett, 2000). These factors are reflected in the current study of gender differences in the science apprenticeship program.

Gender Differences in STEM Studies and Career Choice

Gender perceptions often dictate the process of choosing a career. Historically, care has often been viewed as "natural" to women and consequently influences the professional roles that women are deemed best suited to perform, for example, teaching young children (Cameron, 2001; Peeters, 2008; Warin & Gannerud, 2014). Gender differences in education do not always indicate advantage for boys. Weaver-Hightower (2003) reported disadvantages for girls in math and science and for boys in reading and writing. However, STEM factors relating to learning experiences have been associated with gender difference. Studies demonstrated that boys have a more positive attitude toward science in school than girls. Moreover, this gap widened rapidly with age and was largest for physics (Baram-Tsabari & Yarden, 2010; Hoffmann, 2002; Krapp & Prenzel, 2011; Linn, 1980a, b; Linn & Pulos, 1983; Osborne et al., 2003; Trumper, 2006).

Several studies have indicated that traditional gender stereotyping affects girls' interest in science. Stereotypes about female inferiority in science and mathematics are prominent among children and adolescents, parents, and teachers. Parents and teachers tend to overrate boys' ability relative to girls' and encourage boys more than girls to develop ideas, think independently, be active and speak, and appreciate competence as more important in education. Stereotypes about gender and science and mathematics predict children's perceptions of their own abilities, which may create gender differences in science participation or performance (Bailey, 1992; Bouchey & Harter, 2005; Furnham, Reeves & Budhani, 2002; Häussler & Hoffmann, 2002; Kelly, 1987; Kiefer & Sekaquaptewa, 2007; Li, 1999; Marshall & Reihartz, 1997; Nosek et al., 2009).

Teaching and learning methods were found in various studies relevant to the issue of gender differences. Females perform better when they are able to articulate their thoughts verbally in an interactive environment that enhances cooperation among students and decreases competitiveness (Sasson & Cohen, 2013; Sasson & Dori, 2015; Lorenzo, Crouch & Mazur, 2006). The effect of the type of class, single-sex or co-educational class, on gender differences is inconsistent. Häussler and Hoffmann (2002) and Jones and Young (1995) found that girls from single-sex physics classes reported a better physics-related self-concept of ability than girls from co-educational classes, while boys' self-concept of ability did not vary according to class composition.

Osborne et al. (2003), on the other hand, remarked that single-sex learning did not increase girls' participation in physics classes.

Time and time again, arguments are made asserting a biological basis for observed gender differences in the fields of math and science. However, recent cross-cultural studies have demonstrated that the differences in math and science performance between men and women are not rooted in their biology, but rather are the result of strong sociocultural influences. Kane and Mertz (2012) analyzed the math performance of boys and girls across more than 26 countries. The results indicated that math achievement was higher in countries where there is greater gender equity. Thus, given an equal playing field, boys and girls will perform at the same level. The challenge is to provide this environment.

The purpose of this study was to evaluate how the graduates from a research apprenticeship program for 11th and 12th graders perceived their experience as affecting their choice to specialize in a STEM career and to determine whether there were gender differences in the perceptions indicated. The research questions were

1. What are the participants' perceptions of the research apprenticeship program's contributions to them? Are there gender differences in their perceptions?
2. How do the graduates perceive their experience as a factor affecting their choice to specialize in a STEM career? Do women and men perceive this differently?
3. What are the graduates' attitudes toward the factors that might influence young people to continue to engage in a STEM career as adults? Are there gender differences in these attitudes?

Method

In this research, we used the sequential mixed-method approach, in which the research phases are conducted consecutively, with subsequent phases dependent upon the previous ones (Teddlie & Tashakkori, 2009). Research tools included interviews and questionnaires. The research tools included interviews and questionnaires, the combination providing a high level of validity, reliability, and generalizability but also depth and flexibility (Johnson, Onweugbuzie & Turne, 2007).

Procedure and Research Tools

In the first stage, interviews were held with 24 11th and 12th graders who participated in the research apprenticeship program (15 girls and 9 boys). The interviewees were randomly selected from the 80 participants in the academic year 2015–2016. The interviews took place face to face during the students' arrival at the campus program meetings. Based on the interview results, a questionnaire was developed for program graduates, a process that took place about a year after the interviews. Most of the graduates preferred to answer a telephone survey, yet some completed a computerized questionnaire sent to them by e-mail after telephone contact (with identical questions). The questionnaire included two parts. The first part included demographic details and questions regarding the graduates' current occupation. The second part evaluated graduates' attitudes toward the possible contributions of the research apprenticeship program (five categories containing a total of 15 statements tested) and toward the factors with potential for influencing young people to continue engaging in a STEM career as adults (two categories containing a total of 11 statements tested). A Likert scale was used with the following range for each statement: 5—"strongly agree," 4—"agree," 3—"undecided," 2—"disagree," and 1—"strongly disagree." Tables 1 and 2 present the categories and the reliability values for each variable.

Population

Out of a total of 155 graduates (51% women and 49% men), 116 (75%) responded to the questionnaire. The average age of the respondents was 19.6 years; the standard deviation was 1.46, and the median was 19. The youngest was 18, and the oldest was 23 years old. The respondents represent six sessions of the program: 20% from 2016 (responding to the questionnaire 3 months after completing the program), 28% from 2015, 22% from 2014, 6% from 2013, 17% from 2012, and 5% from 2011. Two graduates did not note the year of program completion. Approximately 10% of respondents (from 2016 session) participated in the first part of the study in the interview phase.

Results

According to the mixed-method approach, the findings will be presented in two stages. The qualitative analysis of the interviews is presented first, followed by the findings of the quantitative questionnaire developed from the interview findings.

Qualitative Results

Most of the high school students' responses to interviews were positive with respect to the program. Very few mentioned difficulties encountered during their participation in the program that resulted from poor interaction with the mentor or technical problems.

Table 1 Possible contributions of the science program

Category (no. of statements)	Examples	Cronbach alpha reliability coefficients
Development in science studies (3)	"*The program contributed to the deepening of my scientific knowledge*"	0.830
Development of learning skills (2)	"*The program contributed to my ability to write research work on an academic level*"	0.628
Science self-efficacy (3)	"*Participation in the program made me feel a better student in STEM*"	0.767
STEM career choice (6)	"*The program helped me to understand what I would like to do for a living in the future*"	0.719
Sense of belonging to the residential area (1)	"*Participation in the program increased the chance that I would return to live and work in the region after completing my academic studies*"	–
Total (15)		0.880

Table 2 Factors influencing young people to continue to engage in STEM career as adults

Category (no. of statements)		Examples	Cronbach alpha reliability coefficients
Person inputs—pre-dispositions (1)		"*Motivation and personal will*"	–
Background environmental influences (10)	Role model (2)	"*Personal contact with a person in the field of STEM*"	0.811
	Program support (5)	"*Participation in science research program in high-school*"	
	Emotional support (1)	"*Support and encouragement from the immediate surroundings*"	
	Financial support (1)	"*Ensuring scholarships for academic studies in the field of STEM*"	
	Positive experiences (1)	"*Positive educational experiences in the field of STEM*"	
Total (11)			0.799

Interviews with the high school students revealed four main themes of contribution from their participation in the research apprenticeship program: contribution to science learning, development of self-efficacy, effect on students' choice to specialize in science and technology in the future, and sense of belonging to the residential area. The students recognized the unique resources of the program that are not available in their schools: the accessibility to advanced labs, research topics, and expert staff. They perceived such advantages as contributing to their development in science studies. With regard to the theme of contribution to science learning, students said:

> *I learned a great deal about the scientific subject that interested me and I experienced writing a high-level research report. I was exposed to a specific topic in a field I would not have had access to otherwise. I have experienced and learned how to work with special tools in an advanced laboratory* [student no. 13, ♂].

> *The program contributed to my personal science knowledge, I learned a lot. Thanks to the program I know how to write papers better. My ability to write a paper well also helps me write papers in school subjects like literature* [student no. 10, ♀].

Contribution to science learning includes the preparedness for higher education studies. Students appreciated the experience as valuable for developing their ability to write academic papers, locate sources of information, and improve English reading skills. Several students indicated the contribution to their ability to organize and manage learning time. One of the students stated:

> *The program gave me a lot! I got a lot of learning tools with which I researched and wrote an academic paper, I learned how to look for information sources; I*

> *learned ways of thinking and how to correctly write the research question* [student no.7, ♂].

The second theme was contribution to self-efficacy. The program strengthened students' sense of self-confidence in coping with learning, particularly in preparation for future academic studies. Students said:

> *At first it sounds like something impossible to achieve. But as the process progressed, I proved to myself that I can, that I can succeed. I understood that if this worked, then I'll be able to deal later with bigger things and difficulties* [student no.12, ♀].

> *The science project that I conducted proved that I can work in the future in the scientific field. If I succeeded in doing that I could surely do more* [student no. 21, ♀].

> *The program affected me a lot! As a result of the program I participated in other projects that I had been afraid to participate in and take on a great responsibility. I think it made me feel much more capable* [student no. 4, ♀].

> *Before I took part in the program, when I thought about studying at the university it seemed very hard to me. When I started the program, I discovered that it was not so bad. I found it challenging and that I could handle it. Today, I appreciate myself more and I'm not afraid to study at university* [student no, 3, ♀].

The third theme refers to increasing positive attitudes toward STEM and the effect on students' choice to specialize in science and technology in the future. Students stated: "*I think the program has affected my interest in chemistry and biology, and maybe I will choose to study these areas in the future*" [student no. 5, ♂] and "*As a result of participating in the program, I understood more deeply what this world of science is, and I think that I will continue in this field in the future*" [student no. 10, ♀].

An additional contribution of the program was that it exposed students to the scientific research of academic and research institutes in their residential area, introducing them to local employment opportunities. Students said:

> *I wasn't aware of the existence of these research fields in my city. I didn't know that there is a medical research institute in my city* [student no. 17, ♀].

> *I discovered that the city of Safed has a branch of the Faculty of Medicine* [of Bar Ilan University], *I was exposed to clinical study in the Galilee and I discovered that medicine in the periphery is more developed than I thought. Learning here is now an option more than before* [student no. 10, ♂].

Quantitative Results

The first section of the questionnaire sought demographic and career information. Of the graduates who responded to the questionnaire, most (75%) majored in science during their high school studies (5 matriculation examination study units). Only 6% majored in social sciences and humanities (the remainder did not reply to the question). Most of the graduates who responded to the questionnaire (73%) were waiting to or serving in the military (compulsory for men and women at 18), 9% were relatively close to release from the military, 16% were studying at university (69% in STEM faculties), and 3% of the graduates were employed full time.

With regard to family influence, the results indicate that 52% of respondents have close family members with careers in STEM. With regard to personal aspirations, 59% of graduates responded that they intended to choose a career in STEM, 11% responded in the negative, and 24% responded that they did not yet know (6% did not reply to the question). Pearson test analysis indicated no significant correlation between ties to family engaged in STEM and the graduate's desire to engage in this field in the future. Chi-squared test analysis indicated no significant correlation between gender and the graduate's desire to engage in STEM in the future.

The second section of the questionnaire examined the graduates' attitudes regarding the contributions of the research apprenticeship program and the factors that may influence the choice of a career in STEM. In contrast to the very high response rate of graduates to the first part of the questionnaire, here the response percentage was lower. Of the 116 total respondents, 84 (nearly 73%) answered at least 80% of the questions and were included in the next statistical analysis; the remainder were excluded from the sample.

Relatively positive attitudes were found for development in science studies ($M = 4.09$, $SD = 0.97$), development of learning skills ($M = 3.63$, $SD = 0.96$), and science self-efficacy ($M = 3.46$, $SD = 1.0$). Low attitudes were found for contribution to STEM career choice ($M = 2.86$, $SD = 0.84$) and sense of belonging to the residential area ($M = 2.11$, $SD = 1.21$). Gender differences were found between females and males. Table 3 presents the results.

The data indicate more positive attitudes among females in relation to program contributions in most of the categories measured. Significant gender differences with relatively medium–high effect size values were found in the following categories: development in science studies, science self-efficacy, and STEM career choice. Marginal

Table 3 Graduates' attitudes regarding contributions of the science program—by gender

Category	Mean—females $N = 44$ (SD) (min = 1, max = 5)	Mean—males $N = 40$ (SD) (min = 1, max = 5)	*t* test comparison	Effect size Cohen's *d*
Development in science studies	4.33 (0.96)	3.82 (0.92)	$t = -2.43$, $p = 0.01$	0.532
Development of learning skills	3.83 (0.88)	3.42 (1.01)	$t = -1.95$, $p = 0.05$	0.427
Science self-efficacy	3.75 (1.00)	3.13 (0.93)	$t = -2.90$, $p = 0.005$	0.633
STEM career choice	3.07 (0.86)	2.62 (0.75)	$t = -2.36$, $p = 0.01$	0.515
Sense of belonging to the residential area	2.28 (1.27)	1.93 (1.12)	n.s.	–
Total	3.51 (0.77)	3.02 (0.64)	$t = -3.11$, $p = 0.003$	0.678

n.s. not significant

$p > 0.05$

significance with relatively low effect size value was found for the category development of learning skills, and no significant difference was found for sense of belonging to the residential area. Pearson test analysis indicated that there is a significant low and positive correlation between students' attitudes toward development in science studies and the graduate's desire to engage in this field in the future, $r^2 = 0.335$; $p = 0.002$.

In the next stage of the analysis, a regression test was performed to predict the graduates' expectation to take up a STEM-related career. The predictors were contribution of the program to the development of science studies, development of learning skills, self-efficacy, and sense of belonging to the residential area. All the models were significant. This indicates that positive attitudes of program participants regarding the development of their skills in the sciences, their sense of self-efficacy, and their connection to the region predict positive attitudes toward the intention to pursue a future career in a STEM field. Table 4 presents the results of the regression test.

Graduates' attitudes toward the factors that can influence young people to choose a STEM career as adults were analyzed in the first stage for all respondents and then sorted by gender. Graduates perceive the person inputs and his or her pre-dispositions to motivation and personal will, as the most influential factor with regard to career choice in STEM ($M = 4.74$, SD = 0.46). The mean for background environmental influences was 3.85 (SD = 0.60).

No significant difference between genders was found in their attitudes toward person input factors. Significant differences were found between genders in the category of background environmental factors, $t = -2.178$; $p = 0.008$; effect size Cohen's $d = 0.478$ ($M_{\text{females}} = 4.01$, SD = 0.60; $M_{\text{males}} = 3.67$, SD = 0.54). Table 5 presents the results for the various sub-categories.

The weightiest factor perceived by graduates in the category of background environmental influences was their positive STEM educational experiences during their

Table 4 The regression model

Model	Significant	R square	Regression equation	Standardized equation
The regression model for predicting graduates' expectation to take up a STEM-related career by attitudes toward self-efficacy	$F = 58.79$ $p = 0.000$	41.8%	$y = 1.010 + 0.534x$	$Zy = 0.646 \times zx$
The regression model for predicting graduates' expectation to take up a STEM-related career by attitudes toward development of learning skills	$F = 55.11$ $p = 0.000$	40.2%	$y = 0.848 + 0.553x$	$Zy = 0.634 \times zx$
The regression model for predicting graduates' expectation to take up a STEM-related career by attitudes toward development of science studies	$F = 27.84$ $p = 0.000$	25.3%	$y = 1.074 + 0.436x$	$Zy = 0.503 \times zx$
The regression model for predicting graduates' expectation to take up a STEM-related career by sense of belonging to the residential area	$F = 21.33$ $p = 0.000$	20.8%	$y = 2.207 + 0.315x$	$Zy = 0.457 \times zx$

Table 5 Graduates' attitudes regarding factors that influence career choice in STEM—by gender

Sub-category	Mean—females $N=44$ (SD) (min = 1, max = 5)	Mean—males $N=40$ (SD) (min = 1, max = 5)	*t* test comparison	Effect size Cohen's *d*
Positive experiences	4.48 (0.66)	4.25 (0.84)	n.s.	–
Emotional support	4.45 (0.87)	4.20 (0.99)	n.s.	–
Role model	4.27 (0.71)	4.08 (0.85)	n.s.	–
Program support	3.79 (0.71)	3.29 (0.81)	$t=-2.991$, $p=0.004$	0.653
Financial support	3.77 (1.03)	3.75 (0.95)	n.s.	–

n.s. not significant

$p > 0.05$

lifetime. The data indicate significant gender differences with relatively high effect size value in graduates' attitudes toward the influence of program support. Females perceive participation in science programs as more influential on career choice in STEM in comparison to males. Given that the science program takes place at a higher age (secondary versus elementary school), it is perceived as having more influence on career choice (for high school programs: $M=3.79$, $SD=0.94$, for middle school: $M=3.25$, $SD=1.19$, and for elementary school: $M=2.90$, $SD=1.29$).

Discussion

The goals of this study were to evaluate how graduates from a high school research apprenticeship program perceive their experience as a factor affecting career choice in STEM and to determine whether gender differences affect those perceptions. Assessing the scientific program's potential is essential for understanding its effectiveness in shaping the participants' career choice. The process enables identifying whether the program is a generator of key educational experiences that participants will define retrospectively as catalysts for realizing unacknowledged potential, opportunities, and skills in STEM. Key experiences are characterized by cognitive stimulation and emotional excitement, coupled with a process of self-discovery (Yair, 2003).

The program is voluntary; students chose to participate in an out-of-school framework in the afternoon for about a year and a half. Hence, the participants were probably pre-disposed toward STEM studies (see for example Sasson, 2014). In light of this, the assumption was that the potential change (or the relative improvement) of attitudes throughout participation in the program would not be high. Therefore, a measurement of the graduates' perception of the program's contributions was chosen rather than their attitudes toward STEM at the beginning and at the end of the program.

About half of the participants in the science program did not have close family members working in STEM fields. This finding attests to the crucial role of the program in exposing to the scientific inquiry process students who do not have role models in STEM fields. Most of the graduates indicated that they intended to work a STEM field in the future. Only 11% said they did not. There was no connection between the intention to choose a career in the sciences and the family background of the participants or their gender. This finding may be related to the early affinity to STEM characterizing the students who chose to participate in the program. The relatively low perceptions of graduates regarding the contribution of the research apprenticeship program to their career choices in STEM may support this conclusion. Prior research indicates the impact of participation in research apprenticeship programs on the career choice of participants. Several studies indicated that apprenticeship programs helped students confirm and clarify their decisions to pursue scientific careers (Abraham, 2002; Gonzalez-Espada & LaDue, 2006; Seymour, Hunter, Laursen & Deantoni, 2004).

The results revealed four main contributions of the research apprenticeship program: development in science learning, development of self-efficacy, effect on students' choice of specializing in science and technology in the future, and sense of belonging to the residential area. Some of the themes are in line with those identified by Abraham (2002) who analyzed high school students' pre- and post-open-ended responses and indicated that participation in a field-based research apprenticeship program had a profound effect on their science understanding, their affinity for science, and their perceptions of the work of scientists. Themes revealed here are also consistent with the study of Hunter, Laursen, and Seymour (2007) who investigated the benefits and costs of undergraduate engagement in faculty-mentored, authentic research during the summer. Analyzing interviews they found four primary benefits: personal-professional gains including increased confidence in ability to do science research, progress in various skills such as presentation or oral argumentation and writing, clarification or confirmation of career plans, and enhanced career or graduate school preparation. The findings here that the "personal-professional gains" category was the largest set of gains identified support the prior research. Perception of the contributions of the program was similar to that found in the research of Hunter et al. (2007) even though this study involved high school and not university students. It is likely that the high school graduates were (as yet) unaware of the significance of some of the academic benefits and hence the difference with regard to that specific finding.

Female graduates had more positive attitudes regarding program contributions in most of the categories measured except for sense of belonging to the residential area (where the differences were not statistically significant). Women perceived the program as more valuable to them than men. In addition, significant gender differences were found in graduates' attitudes toward the factor of "program support" as influencing young people to engage in STEM careers as adults. Young women more than young men perceived participation in science programs as more effective in influencing career choice in STEM. This finding is consistent with Campbell (2002), who explored the contributions of an apprenticeship research experience to women's success in science. Her results suggest that interactions with mentors and practical science experience heightened female undergraduate interest in and preparation for science careers.

A possible interpretation of the gender differences found here may be related to the variable of emotional intelligence, which was not examined in this study. Girls may be more reflective and aware of their life experiences. Emotional intelligence includes the ability to regulate emotions to promote emotional and intellectual growth (Mayer & Salovey, 1997). Several studies found that women have higher emotional abilities than men (Cabello, Sorrel, Fernández-Pinto, Extremera & Fernández-Berrocal, 2016; Das & Sahu, 2015).

The effectiveness of the research apprenticeship program may result from its design characteristics that are rooted in the psychology of learning's constructivist approach.

According to constructivism, students independently and actively build their cognitive world by interacting with the world during real learning events. In this way, knowledge reflects the image of reality as individuals, themselves, have constructed it (Atkins, 1993; Ertmer & Newby, 1993; Nagowah & Nagowah, 2009; Rivet & Krajcik, 2004; Rosenfeld & Rosenfeld, 2006; Von Glaserfeld, 1991). Researchers have found constructivist learning environments effective for developing transfer skills. Transfer is defined as the effect of knowledge learned in a previous situation/task on learning or performance in a new situation/task (Dori & Sasson, 2013; Sasson & Dori, 2006, 2011, 2015; Mayer & Whitrock, 1996). The constructivist theory assumes that transfer is facilitated by involvement in authentic tasks and understanding is "indexed" by experience, both key design elements in the research apprenticeship program.

There is a lack of studies on research apprenticeship programs for secondary students (Burgin, Sadler & Koroly, 2012). This research has several limitations that are important to reduce in follow-up studies. As noted, program contributions were examined implementing quantitative and qualitative tools at one point in time. It is reasonable to assume that some of the participants will choose a scientific career regardless of their participation in the program. Further research is needed to investigate whether the research apprenticeship program serves an important role in increasing participation in STEM studies or if it primarily benefits students who have already decided to pursue STEM degrees and careers?

With regard to the program's graduation year, there is a relatively low representation from each year in the current study, so it was not possible to analyze the effect of the time from the end of the program on the graduates' attitudes. It is important to examine this issue in further research among a larger number of participants.

Further research is also needed in order to link desired outcomes to aspects of the research apprenticeship experience. For example, more research is needed about the effect of student-mentor interactions on achieving the educational goals. Mentors play a central role in apprenticeship experiences, distinguishing this program from other science programs.

Despite its limitations, the present study contributes to a deeper understanding of the gender gaps in science education. It also sheds lights on the relationship between the characteristics of intervention programs and the perceptions of young women and men. This contribution is particularly evident in view of the findings indicating a positive correlation between the attitudes of the program participants and their expectation to embark on a STEM-related career.

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