

Operation Minerva: Calgary 3 Year Study 2006

Terri L. MacDonald

Research Consultant

Perception Research

Nelson, BC, V0G 2J0

tmacdona@uniserve.com

ABSTRACT

THIS PAPER PRESENTS FINDINGS FROM THE FIRST YEAR OF A THREE YEAR STUDY EXPLORING THE IMPACT OF A JUNIOR HIGH SCIENCE INTERVENTION PROGRAM FOR GIRLS. THE PURPOSE OF THE STUDY IS TO EXPLORE THE EFFECTS OF THE OPERATION MINERVA PROGRAM ACROSS EDUCATIONAL SECTORS (PUBLIC, CATHOLIC, ALTERNATIVE) WITH RESPECT TO THE INTERVENTION EXPERIENCE, COURSE AND CAREER PLANS, AND ATTITUDES AND FACTORS INFLUENCING FEMALE SCIENCE RETENTION. FINDINGS SUGGEST THAT THE OPERATION MINERVA PROGRAM IS EFFECTIVE AT ENCOURAGING GIRLS TO PURSUE SCIENCE AS EVIDENCED BY 66% OF PARTICIPANTS REPORTING PLANS TO ENROL IN AT LEAST THREE (LEVEL 30) SCIENCE AND MATH COURSES, 92% REPORTING PLANS TO PURSUE POST-SECONDARY SCIENCE AND 90% REPORTING PLANS TO PURSUE A CAREER IN SCIENCE. AN EXPLORATION OF ATTITUDES AND FACTORS INFLUENCING SCIENCE RETENTION REVEALS CONTINUING CONCERNS RELATED TO FAMILY-CAREER BALANCE AND THE POSITIVE IMPACT OF INTEREST AND ABILITY, FEMALE SCIENCE ROLE MODELS, APPLIED SCIENCE EXPERIENCES, AND PARENTAL SUPPORT. FINDINGS ARE DISCUSSED AS THEY RELATE TO INTERVENTION PROGRAM ORGANIZERS, FEMALE SCIENCE MENTORS, EDUCATORS, AND STAKEHOLDERS FROM INDUSTRY AND GOVERNMENT.

INTRODUCTION

Driven by concerns over junior high girls losing interest in science, the Operation Minerva Program was established to provide girls with hands-on experience in various fields of science and engineering. The program, now in its 15th year in Calgary, has expanded to urban and rural areas across Alberta (e.g. Red Deer, Medicine Hat, Fort McMurray, Athabasca and Pincher Creek). Approximately 90 girls and 45 female science mentors participate in the one-day Calgary Operation Minerva Program in May of each year. Student participants job-shadow their mentor and participate in hand-on activities that bring out special aspects of the job. For example, a mentor in the oil and gas industry demonstrated how one can drill for oil by removing chocolate from a cake “ground”. Students have also utilized three-dimensional software for generating geological models and examined mutations in fruit flies through the use of a specialized microscope.

The purpose of the study is to explore the effects of the Operation Minerva Program across educational sectors (public, catholic, alternative) with respect to the intervention experience, course and career plans, and attitudes and factors influencing female science retention. The experiences of both students and science mentors are explored. Recommendations are provided for intervention program organizers, educators, women scientists, and stakeholders from industry and government. This paper presents findings from 2005, the first year of the 3-year study.

RESULTS

The Operation Minerva Experience

Participants indicated the most enjoyable and interesting features of their job shadowing experience were *hands on activities (35%), exposure to applied science examples (22%), learning about science careers (13%), visuals & presentations (12%), exposure to female science role models (10%), exposure to new technologies (7%), games (7%), and interacting with other students (5%)*. The least enjoyable aspects of the job-shadowing experience included: *lectures & meetings (20%), certain aspects of specific science applications (11%), disorganization / transportation (7%), presentations (6%), amount of information (4%), and not enough hand-on / applied science activities (2%)*.

Participants recommended the following improvements to the Operation Minerva Program: *lengthen the experience (18%), more hands-on / applied science activities (16%), match student preferences to type of job shadowing experience (11%), smaller participant groups (9%), more diversity of job experiences (9%), and improved coordination of transportation (5%)*.

Plans for Science Studies and Career Choice

66% of Operation Minerva participants plan to pursue at least three Level 30 senior math and science courses. As outlined in the table below, 77% of Operation Minerva participants plan to enroll in Pure Math 30, 67% plan to enroll in Chemistry 30, 66% plan to enroll in Biology 30, and 48% plan to enroll in Physics 30. These findings suggest that Operation Minerva is effective at encouraging girls to enroll in senior high school science and math courses. Level 30 science and math courses are a requirement for most post-secondary science programs and as such are critical to the pursuit of a career in science. The lower percentage of students planning to enroll in Physics 30 is consistent with Johnson's (1987) finding that girls enroll disproportionately more in senior high biology courses while avoiding other sciences, especially physics (Johnson, 1987).

According to educational sector representation, the highest number of Operation Minerva participants planning to enroll in Pure Math 30 (85%) and Physics 30 (56%) were from the public sector. The highest number of Operation Minerva participants planning to enroll in Biology 30 (73%) and Chemistry 30 (67%) were from the alternative sector. As presented in the table below, a high number of Operation Minerva participants from the Catholic sector also indicated plans to pursue senior high science and math courses.

TABLE 1. PLANNED ENROLLMENT IN SENIOR SCIENCE & MATH COURSES (%)

Senior High Courses	All Sector Average	Public Sector	Catholic Sector	Alternative Sector
Pure Math 30	77	85	72	73
Chemistry 30	67	67	66	69
Biology 30	66	67	59	73
Physics 30	48	56	41	46

61% of Operation Minerva participants planned to pursue a post-secondary science degree or diploma, 31% of participants planned to pursue at least one post-secondary science course, and 4% planned *not* to take a post-secondary science course. Considering 92% of participants planned to pursue either a science degree / diploma or at least one post-secondary course reveals that Operation Minerva is effective at encouraging girls to pursue science at the post-secondary level.

TABLE 2. PLANNED ENROLLMENT IN POST-SECONDARY SCIENCE BY SECTOR (%)

Post-Secondary Science Choices	All Sector Average	Public Sector	Catholic Sector	Alternative Sector
post-secondary science degree or diploma	61	67	52	65
post-secondary science course	31	26	45	23
no post-secondary science	4	4	0	8
none of the above	4	4	3	4

A comparison of educational sectors reveals a high number of public (67%) and alternative (65%) sector participants indicated plans to pursue a post-secondary science degree. A significant number of Catholic sector participants (52%) also indicated plans to pursue a post-secondary science degree or diploma.

TABLE 3. CONSIDERATION OF A SCIENCE CAREER(%)

Career Plans	All Sector Average	Public Sector	Catholic Sector	Alternative Sector
Science-related career	90	93	90	88
Non science-related career	10	7	10	12

90% of Operation Minerva participants indicated plans to pursue a science-related career. This finding suggests that Operation Minerva is very successful at encouraging girls to pursue science careers. Sector comparisons reveal minimal deviation. Themes from qualitative data included comments related to *preferred occupations (52%), the influence of interest in science & career opportunities (32%), uncertainty over career choice (12%), and the positive impact of the Operation Minerva Program (9%)*.

Attitudes Influencing Science Career Choices

As stated in the methodology, questions relating to attitudes influencing science retention were taken from Smith & Erb's (1986) Women in Science Scale (WiSS), a tool used to measure attitudes of adolescents toward women in science careers. Five attitudinal statements from the twenty-seven item scale were chosen for inclusion in the current research as a follow-up to a retrospective study of 1991 Operation Minerva Program participants. (MacDonald, 2000) A 6-point Likert scale was used for each statement (strongly disagree to strongly agree; 1 - 6). While these statements do not relate specifically to science careers, they do focus mainly on attitudes related to family – career balance from the female perspective. The table below presents levels of agreement (including somewhat to strongly agree) for each statement.

TABLE 4. AGREEMENT WITH WOMEN IN SCIENCE ATTITUDINAL STATEMENTS (%)

Attitude Statements	All Sector Average	Public Sector	Catholic Sector	Alternative Sector	Mentors
Careers are good for women as long as they are not the boss.	2	7	0	0	0
A woman's basic responsibility is raising children.	6	11	3	4	14
Getting married is the most important thing in a woman's life.	12	7	17	12	3

For a woman it is more important to be a successful wife and mother than it is to be successful in a career.	16	22	21	4	3
It is better for a woman to study home economics than chemistry.	6	4	10	4	0

16% of Operation Minerva Participants (all sectors) agreed that *for a woman it is more important to be a successful wife and mother than it is to be successful in a career*. 12% of participants agreed that *getting married is the most important thing in a woman's life*. Mentors strongly disagreed with four out of the five attitudinal statements. However, 14% of mentors agreed that *a woman's basic responsibility is raising children*. Mentors' priority on motherhood is an interesting contrast to girls' continued concerns related to getting married and family – career balance. While the above statements were described by participants (students and mentors) as *outdated* and *archaic*, it is a useful exercise to explore controversial attitudes related to career choices, marriage and family.

Factors Influencing Science Retention

Potential factors influencing science pursuits were generated from a literature review and qualitative findings from MacDonald. (2000, 2004) The table below presents levels of agreement (including somewhat to strongly agree) for each factor across sectors and also includes mentor responses. Strongest reported influences include: *interest in science (84%)*, *impact of female role models / mentors (82%)*, *science ability (79%)* and *impact of classroom learning (76%)*. A high number of participants also reported *parental influence (69%)*, *impact of 'out of school' science experiences (67%)* and *impact of the peer network (60%)*. 35% of participants reported *media* and 18% of participants reported *traditional stereotypes* as factors influencing their decision to pursue (or not to pursue) science.

TABLE 5. FACTORS INFLUENCING SCIENCE RETENTION (%)

Factors Influencing Science Attrition	All Sector Average	Public Sector	Catholic Sector	Alternative Sector	Mentors
interest in science	84	81	79	92	93
impact of female role models	82	81	79	85	41
science ability	79	89	72	77	79
impact of classroom learning	76	89	65	73	83
parental influence	69	85	51	73	69
impact of 'out of school' science experiences	67	78	58	65	76
impact of peer network	60	59	52	69	41
impact of media	35	41	38	27	17
traditional science stereotypes (scientists are men)	18	26	13	15	14

Qualitative comments reinforce the impact of the following factors on science choices: *science interest (11%)*, *impact of the Operation Minerva Program (6%)*, *school influences (5%)*, *media and stereotypes (5%)*, *applied science experiences (2%)*, *peer network (2%)*, *parents*, and *other (12%)*. Results support findings from MacDonald's (2000, 2004) retrospective study of Operation Minerva participants highlighting influences on science career choice including: *parental influences*, *the positive impact of the Operation Minerva Program*, *interest and ability*, *experiential learning*, and *the negative influence of 'chilly' secondary and post-secondary chemistry learning climates*. Also of interest are influences

indicated by mentors in comparison to Operation Minerva participants. Findings suggest that mentors underestimate the potential influence of *female role models / mentors, girls' peer networks, and media.*

RECOMMENDATIONS

Findings from this evaluation suggest that the Operation Minerva is effective at encouraging girls to pursue science as evidenced by 66% of participants reporting plans to enroll in a minimum of three senior (Level 30) science and math courses, 92% reporting plans to pursue post-secondary science and 90% reporting plans to pursue a science career. An exploration of attitudes and factors influencing science retention reveals continuing concerns related to family-career balance and the positive impact of interest and ability, female science role models, applied science experiences, and parental influence.

Operation Minerva improvement efforts should be aimed at lengthening and diversifying job shadowing experiences, continuing to work with mentors to ensure girls are engaged in applied and hands-on science activities, ensuring mentors address concerns over family-career balance, matching job shadowing placements with student preferences, and implementing the Operation Minerva Program in other jurisdictions. The success of Operation Minerva Programs rests on community commitment, regardless of stakeholder affiliation. From educator to scientist to parent to concerned citizen, everyone has an important role to play. Each city or town that hosts Operation Minerva is responsible to recruit volunteers and mentors, solicit funds for project costs, locate space and necessary equipment, and coordinate publicity. The growth of the program across Alberta indicates that communities are willing to support young women in their scientific pursuits.

Intervention programs such as Operation Minerva Program positively impact attitudes toward science, secondary and post-secondary science course enrolment, and the consideration of a science career by females. However, some areas of concern continue to persist, including the compatibility of a science career and family life, the persistence of 'chilly' academic and professional climates, contradictory cultural messages, and the adherence to traditional science teaching methods. Recent science retention strategies have employed single-sex classrooms / schools designed to encourage girls' self-esteem in non-competitive and inclusive environments. The Internet is also being utilized to foster mentorship relationships through programs like the SCIBerMENTOR Program in Alberta that links girls aged 11 to 18 with female university science students in order to encourage the pursuit of a career in science, math or engineering. Other initiatives are directed at boys' underachievement based on an understanding of gender differences. Boys' (under) achievement is grounded in power, achievement and behaviour as defined by the local community and peer groups, opposed to the influence of low self esteem on girls' science attrition. (Younger, Warrington, McLellan, 2002). These new insights expose the importance of giving careful consideration to gender concerns, as applied to both males and females, especially during adolescence. Adolescence is a time when peer group and social pressures become extremely influential for both genders, while at the same time academic choices definitively open (or close) career paths.

The success of future science retention efforts rests on the understanding and contribution of a cross-section of stakeholders, including educators, intervention program organizers, women scientists, and stakeholders from community, industry and government. Women scientists should make themselves available to intervention programs. Within these programs, role models should continue to address concerns related to family-career balance and engage girls in applied science experiences. Educators should continue to encourage girls in science through the use of hands-on, applied learning experiences and use of 'female friendly' examples and applications in order to address persistent stereotypes. Parents should continue to encourage their daughters in science by engaging in 'out of school' applied science experiences, encouraging secondary and post-secondary science enrollment, and discussing science career options. Other stakeholders from industry and government should continue to support science intervention programs through continued funding support, job shadowing opportunities, and encouraging employees to become mentors. While the Operation Minerva Program envisions a future full of possibilities for females in science, it is up parents, schools and science communities to work together to ensure that this vision becomes a reality.