ABSTRACT
Why do girls join science clubs? What are girls looking for in science clubs and what affect does it have on perceptions, school science competency and career aspirations? The Canadian Association for Girls in Science (CAGIS) is a club to promote, educate and support interest and confidence in science, technology, engineering and mathematics (STEM). It has members aged 7-16 across Canada and beyond. Two datasets are presented: 1) the biennial CAGIS members survey on reasons for joining, interests in and perceptions of STEM and STEM professionals, likes and dislikes, school competency in science, and career aspirations and 2) The CAGIS Application form survey on reasons for joining CAGIS, perceptions of STEM and STEM professionals, favourite science topics, school competency and career aspirations. The results show that CAGIS has been a positive experience, with virtually all respondents indicating that they had learnt new information from CAGIS, over 77% felt that they were doing better in science since joining CAGIS. Additionally, the results indicate that members hold positive views about STEM and over 80% are considering STEM careers.

INTRODUCTION
Research consistently finds that boys are more interested in science, technology, engineering and mathematics (STEM) than girls [1][2][3][4]. While many have identified factors that play roles in these sex differences, Eccles has developed a theoretical model, built on social psychology theories, to guide our understanding of girls’ interest in and decisions for studying STEM [5][6][7]. Eccles and colleagues hypothesize that two sets of beliefs influence STEM interest and choice: a person’s expectations for success and the importance or value the person places on the various options perceived to be available [5][7]. Research on the first component, success expectations, indicates clear sex differences whereby girls underestimate their intellectual skills and have lower self-confidence than boys, particularly in male-typed subjects [7]. Moreover, in mixed classes, boys tend to dominate the STEM activities [8]. For example, boys often dominate computers in a classroom and girls quickly learn that computers are not for them [9]. With
science experiments, research finds that boys again take the active role and girls are often delegated to the role of “secretaries” or “recorders”. The passive role of girls may occur because of different learning styles or because of social pressures [10]. Unfortunately, these roles tend to become consolidated throughout grade and high schools, and confidence and interest in STEM often disappears completely [11].

Research on the second component, value assessments of options, finds that individuals do not consider the full range of options available in making their selections because they are unaware of their existence, they have inaccurate information on the option itself or the possibility of achieving the options, or the options may not fit well with the person’s gender role schema [7]. As Eccles [7] writes: “Assimilation of the culturally defined gender role schema can have such a powerful effect on one’s view of the world that activities classified as part of the other gender’s role are rejected, often unconsciously, without any serious evaluation or consideration.” (P. 590). Moreover, gender role stereotyping occurs early in life; children have clearly defined gender role stereotypes of what is appropriate by age 5 [7]. If children are exposed to few female role models engaged in STEM activities, young girls and boys will be receiving “powerful messages that science is a male preserve”[2]. The internalization of these messages is reflected in studies of girls’ perceptions of STEM. Girls, particularly younger girls, report feeling that boys “know” more STEM, are more adept at experimentation, and that teachers concur [2][7]. Girls also perceive that while boys are assumed to be good at science until proven otherwise, girls have to prove themselves [2]. Girls also perceive science as “hard”, that is, too demanding at the expense of other activities. Moreover, girls usually show lack of information about the nature of scientific or technical careers [2].

CAGIS’s mandate is to influence girls’ interest in STEM by increasing their expectations for success and the value they place on the various options available in STEM school subjects and in career choices.

About CAGIS
The Canadian Association for Girls in Science (CAGIS) is an association for girls by girls. The purpose of CAGIS is to promote, educate and support interest and confidence in science, technology, engineering and mathematics (STEM) among girls. CAGIS was started in 1992 by nine year old Larissa Vingilis-Jaremko, when she became concerned that many girls were turning off science at an early age. Yet Larissa realized the importance of science literacy to Canada’s prosperity in the 21st century. She decided to start a science club to encourage girls’ interest in STEM.

CAGIS is unique in a number of ways. First, it is for girls by girls, meaning that members play major roles in determining CAGIS content, and in running CAGIS through writing the newsletters, the YES Mag features and in helping to organize and run events. Additionally, CAGIS encourages its older members (14-16 years) as helpers and mentors. This fulfills some CAGIS objectives as members not only provide input but they can also develop leadership skills.

Second, outreach and programming, is based on research findings on what “hooks” girls on STEM. Research evidence shows a familiar pattern of girls’ lack of experience with STEM. CAGIS was specifically developed to fill the gender-divide gap. Girls are able to develop their STEM interests and skills at friendly, supportive, single-sex events that work hard to respond to girls’ interests and learning styles. A broad range of STEM topics are introduced from the science of computers to the science of cooking, from making electrical circuits to making lip balm. This normalization of STEM and the introduction of STEM as being part of very day life, is a critical theme for CAGIS. If CAGIS members come to understand that baking a cake is a
series of physical and chemical reactions, and not so different from what occurs in a laboratory, the issue that “science is boys stuff” disappears. The relevance of STEM to everyday life also becomes obvious.

CAGIS members meet monthly during the school year. In a girls-only, social and supportive environment, CAGIS members explore STEM. Members have the opportunity to meet professional women and men who are working with STEM daily. Members are as likely to meet with a microbiologist and learn about the science of microbes as they are to meet with an artist and learn about the science of print-making. In this way members learn about a wide variety of STEM-related professions, and the importance of STEM in many professions not typically associated with STEM, such as architecture, art restoration, etc. Additionally, plenty of time is spent doing hands-on activities. The hands-on activities and girls-only supportive environment help to build comfort, and confidence in STEM and increase their expectations for success.

As part of the yearly membership fee, CAGIS members receive a quarterly newsletter, and a one-year subscription to YES Mag. CAGIS members also develop their writing and leadership skills by writing up their CAGIS events and other stories for the newsletters and the feature column in YES Mag called “What’s Up at CAGIS?” CAGIS has an interactive Website, where members can connect with each other across Canada and the world. The Website is especially important for members who do not live near a Chapter site. The Website has both a public site and a private site with a password secure “Clubhouse” for members only. This private site is monitored for every entry attempt and as such protects members. Through CAGIS members’ involvement, the girls learn about Website technology and how to use the Internet in an appropriate and safe manner.

CAGIS is run primarily on a volunteer basis. Membership fees pay for the magazine subscription, the newsletter and support the volunteer CAGIS Chapter coordinators who organize local CAGIS Chapter events. Additional grant money and charitable donations have assisted with special projects and management costs.

In 1999 and 2001, the CAGIS administrative body developed and mailed out a survey to canvas CAGIS members on their attitudes and perceptions of STEM and CAGIS and on what they wanted CAGIS to offer. Specifically it queried members on what they liked and disliked and what they wanted more or less of in their CAGIS newsletters, CAGIS Website and events. The survey is sent out with the summer CAGIS newsletter biennially. In 2003 a third survey was sent out to members. This study presents the findings of the survey. Additionally, a short survey on the application form queries girls on why they are joining, their favorite subjects and their attitudes and perceptions of STEM. This study presents the findings of the 2003 membership survey. In addition, this study provides the results of a small, random sample of membership application surveys in order to assess whether new members’ attitudes and perceptions of STEM at entry are consistent with attitudes and perceptions of current members.

METHODE

Two questionnaires are included in this study: 1) the biennial CAGIS members’ survey and 2) the CAGIS Application Form survey. To maximize response rate the biennial survey and reminder were sent out twice to members. The first survey was sent out in June 2003 together with the Summer CAGIS newsletter. The President’s message asked members to fill out the anonymous survey and return it to CAGIS. As an enticement for the girls to return their surveys, respondents were asked to put their name and address sealed in a separate envelope to maintain
anonymity, so that their names would go into a draw for a science kit. The survey and reminder was sent out again in September 2003. The questionnaire was one page, double-sided and included 3-point Likert-scale questions and a number of open-ended questions. It asks about reasons for joining, interests in and perceptions of STEM and STEM professionals, likes and dislikes, school competency in science, and career aspirations.

The second questionnaire, the CAGIS Application Form survey, asks six questions on reasons for joining CAGIS, perceptions of STEM and STEM professionals, favourite science topics, school competency and career aspirations. This short questionnaire is part of the application form that is sent into head office. A small random sample was used to compare and contrast the responses of girls who are joining with current members.

RESULTS

A total of 36 surveys were returned for a response rate of 18%. The mean age of members was 11.8 years and their mean length of time as members was 2.5 years. The majority of respondents were from Ontario while seven were from Alberta, one was from Saskatchewan and one didn’t answer.

Members found out about CAGIS from a variety of sources: 33.3% found out from a friend, 27.7% from school, 15.2% from the media (newspapers, magazines, TV), 15.1% from a science centre or camp and 9.1% from a CAGIS chapter co-ordinator.

Most girls (72.2%) liked science before they joined CAGIS and 27.8% somewhat liked science. Since becoming a member of CAGIS 45.7% like science more, 40.0% like it somewhat more and 14.3% don’t like it more. The most common reasons for joining were because they liked science (35.9%) and they thought it seemed like fun (28.2%).

The majority of respondents stated that they are doing better in science since joining CAGIS. 28.6% of members stated that they are doing better, 48.6% are doing somewhat better and 22.9% are doing the same, although many qualified their answer that they were doing well in the first place. Members were also queried about what science topics they liked. Biology was the most popular, followed by chemistry, physics, ecology and astronomy.

The CAGIS newsletter was of interest to most girls: 100% said they read the newsletter. Only 2.8% said they did not like the newsletter. The majority were also interested in writing for the newsletter while 38.9% said they were not interested.

Interestingly, a substantial minority of respondents (44.4%) said they have not checked out the Website, even though 100% said they had internet access. Of the members who said they visit the Website, 94.7% liked the look and presentation of the Website. Similarly 94.1% were positive about the CAGIS Science Squad Webisodes. The experiments and engineering activities featured in the site were highly popular too: 100% of respondents liked them. Almost half (44.4%) stated that they tried some of the experiments and engineering activities.

A majority (55.6%) said they left messages on the message board, 70.6% liked to play games, 100% liked the feature “Great Canadians in Science” and 100% liked Professor Hootie’s Did You Know Facts. Yet, only 13.9% purchased the CAGIS book, Summer of Suspense. Although, all who did like the book, the plot, the characters and the science, would recommend the book to someone else. All respondents liked going to the Chapter events, liked the hands-on activities and found the events a fun way to learn science. They also liked the girls-only environment; 90% liked the same-sex events and many even underlined, circled multiple times or put stars, exclamations for this feature or added comments like “so much!”,”especially”. Almost four fifths (79.4%) of the respondents said they tell their friends about CAGIS.
Respondents were also asked how good they felt they were in science. 47.2% said very good, 41.7% said good, 11.1% said average and no one said poor. Additionally, 60.0% responded that CAGIS helped them do better in science in school, although many added that they were already doing well in school. Importantly 97.1% stated that they learnt new things at CAGIS.

Members were also asked to describe a scientist, engineer, inventor, computer scientist and mathematician. The purpose was to assess whether or not members had a good understanding of what these STEM professionals did and whether any stereotypic views were provided. The good news is that no members provided gender-stereotypic responses; all responses were gender neutral (see Table I). Additionally, dress stereotypes (lab coats and goggles) were offered for the scientist category only. Moreover, intelligence, as a descriptor was offered for scientists, engineers, inventors and mathematicians, but not for computer scientists. The responses were also coded for how positive, neutral or negative the descriptors were. Most were neutral, such as, “someone who studies natural phenomena”. None were negative and a good proportion were ultra-positive. For example, 18.8% of respondents had highly positive descriptions of scientists, such as “heros”, “cool, smart, someone who is very confident in their field”, “dedicated, patient, observant, smart”. For engineering, 16.0% of respondents gave highly positive comments such as, “a person who likes to help humanity by creating solutions for physical problems”. For inventors, 28.6% had highly positive comments, such as “a creative guinness [sic] working to develope [sic] a new machine, knowledge or a technoligy [sic]”. For computer scientists and mathematicians less than 4% of respondents had highly positive descriptions. Finally the responses were coded for their correct descriptions of the professions. The fewest respondents had a correct understanding of engineering, although a good proportion of descriptions were somewhat correct such as, “An engineer works with machines”, “A scientist is someone who mixes potions”.

Table I Percent of respondents who described professions with gender, dress or smartness stereotypic, positive and correct responses

<table>
<thead>
<tr>
<th>Profession</th>
<th>gender stereotype</th>
<th>dress stereotype</th>
<th>smart stereotype</th>
<th>ultra positive</th>
<th>correct</th>
</tr>
</thead>
<tbody>
<tr>
<td>scientist</td>
<td>0%</td>
<td>6.3%</td>
<td>10.7%</td>
<td>18.8%</td>
<td>80.6%</td>
</tr>
<tr>
<td>engineer</td>
<td>0%</td>
<td>0%</td>
<td>4.0%</td>
<td>16.0%</td>
<td>38.9%</td>
</tr>
<tr>
<td>inventor</td>
<td>0%</td>
<td>0%</td>
<td>10.7%</td>
<td>28.6%</td>
<td>75.0%</td>
</tr>
<tr>
<td>computer scientist</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>3.8%</td>
<td>52.8%</td>
</tr>
<tr>
<td>mathematician</td>
<td>0%</td>
<td>0%</td>
<td>7.4%</td>
<td>3.7%</td>
<td>61.1%</td>
</tr>
</tbody>
</table>

Members were asked if CAGIS gave them ideas about career options; 50.0% responded yes. The girls were asked what they wanted to be when they grew up. A wide range of responses were offered, including esoteric jobs like chef, and instrumentation and communications officer. However, 81.3% identified at least one STEM career, with veterinarian as the most popular at 13.2%. Other popular professions included astronaut, doctor and scientist. Of course we also had 18.8% saying actress, dancer, pro skate boarder, a rock star, and pro snow-boarder and most listed a few options such as, “rock star or forensic pathologist”. Teaching was also popular with over 13% saying teacher or science teacher.

Finally, a small random sample of Membership Application Form surveys were analyzed
to assess for consistency of responses to the members’ survey. Reasons for joining were because they liked science, it would be fun, their friends like it, they liked experiments, to learn, out of interest and out of frustration with school: “I wanted to join because...I am so annoyed at all the girls in my class who constantly think science is dumb and boring. I want to be with other girls who think science is fun.” Science ability was queried and 40.0% said they were very good in science, 46.7% said they were good and 13.3% said they were average. Joining members were also asked to describe a scientist; 60.0% correctly described the profession of a scientist. Finally, joining members were queried on their career interests; 61.1% identified STEM careers.

DISCUSSION
The results of the 2003 members’ survey suggest that CAGIS has been a positive experience for its members. Virtually all respondents indicated that they had learnt new information from CAGIS, over three quarters were doing better in science and 60% felt that CAGIS had helped them do better in science. This suggests that CAGIS may be affecting members expectations for success, the first key factor identified by Eccles for influencing girls’ interest in and decisions for studying STEM [5][6][7].

The data also indicate that members have eclectic interests and the variety of activities offered by CAGIS seems to be needed because different members seem to enjoy different things. The newsletter seems important, as are the Chapter events. All members indicated that the hands-on local STEM events were fun and enjoyed. In particular the fact that the events are girls-only seems to be a critically important feature. In fact some girls volunteered in comments that they joined specifically because it was only for girls. However, of concern is the fact that so few CAGIS members checked the CAGIS website. Moreover, the questions on professions indicate that computer scientist had a very small percentage of ultra positive responses. These findings are congruent with other studies [12] that find that girls still seem to be unfavourably disposed to computers and computer science. CAGIS has been working hard through local chapter events on computers, through the various activities on its password protected Website, and through the surveys that ask members what they would like to see on their Website to improve member interest. Thus, it is disappointing that many members still do not access the site.

The good news is that members do not carry stereotypic gender specific views. Between 16-29% of respondents vocalized very positive views about STEM professionals in addition to the accurate definitions provided by other members. Although, the Membership Application Form survey results are not necessarily comparable because of differences in sampling, it is interesting to note that three fifths of applicants had correct descriptions of what a scientist does compared to four fifths of current members. It is hoped that CAGIS has been expanding members’ knowledge of STEM professions. Additionally, half of CAGIS members indicated that CAGIS has provided them with career options. Over 81% indicated their interest in pursuing traditional scientific careers compared to 61% of the girls when joining. This suggests that CAGIS may be expanding members’ awareness of STEM options and affecting their attitudes regarding these options. This is the second key factor identified by Eccles for influencing girls’ interest in and decisions for studying STEM [5][6][7]. However, these members are still young and clearly follow-up research with CAGIS “graduates” would be of interest to identify a link with career choice.

The limitations are that a good proportion of these members self-selected membership in CAGIS, so CAGIS may be preaching to the converted. However, we do have members who received memberships as gifts from relatives and in some cases parents joined their daughters
because they actually disliked STEM. Another limitation is the response rate of under 20%. A challenge is to survey by mail young girls as their ability to fill out questionnaires and mail them out is obviously limited. Thus, it is impossible to know how representative this sample is, although the age of the respondents is somewhat higher than the mean age of the actual membership. Finally, no tests of statistical significance were conducted. Clearly there is the need to collate the responses to the questionnaires over the three waves to increase the sample size in order to have enough power for statistical analyses.

Although care must be taken when drawing conclusions from such limited data, converging evidence (higher interest in science related careers, better understanding of what a scientist is, and slightly higher self rating of science ability) of current CAGIS members compared to girls joining CAGIS suggests that CAGIS may be helping to change attitudes towards and understanding of science and its related professions. Importantly, we hope that CAGIS will influence girls’ interest in and decisions for studying STEM.

REFERENCES


