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Improving girls' attitudes towards science

Bonnie M. Schmidt and Richard Mark Nixon

This study evaluated the effect of an outreach project, called the 'Scientist Badge for Brownies and Girl Guides', on science attitudes and achievement of girls aged 6–12. The programme reached nearly 1500 girls and consisted of ninety minutes of hands-on activities led by university science student volunteers. Participation appeared to improve the image of scientists held by all girls, but especially in the case of the older Girl Guides. Responses to specific statements designed to assess science attitudes appeared to be age-related: compared to older girls, fewer young participants believed that they will be hurt doing science and more believed that they should participate in regular science activities during their meetings. Although all participants enjoyed the programme, there was a steady decline in confidence in their own scientific ability, with obvious drops at ages 8 and 10. It appears that a small effort by volunteers can have a significant impact on both science achievement and attitude of young girls; however, more effort is required to improve the confidence of a group which is at serious risk of avoiding science.

Introduction

During the last decade, much attention has been paid to the issue of increasing the representation of women in technological fields. Nevertheless, women remain clearly under-represented in these occupations. This can be attributed, at least in part, to their lack of science training. There is some question as to why girls do not complete the science courses in school which would allow them to pursue such careers later in life. Explanations which have been offered for this phenomenon range from biological factors[1] and differential cognitive abilities[2] to personality characteristics[3] and socio-cultural factors.[4]

Simpson and Oliver[5] point to the importance of attitudes towards science for achievement in science. A ten-year study by these authors which examined home, school, and individual influences on attitudes toward and achievement in science among adolescent American students uncovered a very strong attitude–achievement relationship. In this study, girls were found to possess more negative attitudes towards science than boys, and they consequently did achieve less, even though they reported a higher motivation to achieve. Partial explanation for this finding may lie in the fact that during their formal science education girls are often treated differently from boys.[6] It has been shown that teachers' praise, expectations, attention, and criticism often differ according to the sex of the pupil.[7] Shepardson and Pizzini have even suggested that teachers are biased in their perception of the scientific ability of their students, believing girls to lack scientific skills.[8] All of these, often subtle, messages could cause young girls to develop negative attitudes towards science.

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Obviously, factors other than attitude also influence achievement. Haggerty, for example, argues that achievement differences cannot be understood without considering the effects of participation as well as attitude.[9] Accordingly, one consistent argument for the lower achievement of girls in the physical sciences is a lack of science experience, both formal and informal. This occurs even though girls do express a strong desire to participate in science activities.[10] It follows that participation in science activities and exposure to science during the growing years are important for establishing the self-confidence and increasing the motivation to achieve which are so necessary for the future pursuit of studies in science.

Participation has to be active for meaningful learning to occur. However, it has been shown that in mixed classes boys tend to dominate science-oriented activities, especially when technical equipment is involved, while girls will assume the role of 'secretary' and often act as helpers.[11] Initially, the passive role assumed by girls may be the result of a different style of learning or may be caused by social pressures. Regardless, such habits begun in childhood are often perpetuated through high school, at which point the level of confidence may be diminished to the point that all interest in science is lost. Consequently, girls may learn science best within a girls-only environment which minimizes differences across the classroom population.[12]

A final motivator for choosing a science career is held to be the exposure of students to positive and realistic role models. Therefore, professional scientists and even students who pursue scientific studies can provide an invaluable service to young girls by volunteering a little time to lead science activities and sharing the fun and excitement that accompanies scientific discovery.

There is much that can be done outside the formal classroom in order to address some of these issues. Indeed, responsibility for increasing the representation of women in science should not fall onto the shoulders of classroom teachers alone. As Tressel points out: 'Most of the time, most of us learn most of what we know outside of school.'[13] Exposure to science should, and can, occur continually throughout a young girl's life, for only those girls who are comfortable with science will be ready to take on the competitive world of science and research.

To address some of these objectives, an outreach programme was initiated in 1994 by Let's Talk Science at the University of Western Ontario. Called the 'Scientist Badge for Brownies and Girl Guides,' this project aimed to expose girls, aged 6–12, to hands-on science activities led by university undergraduate students. During five months of operation, nearly 130 volunteers led evening activities with more than 1500 girls. The objectives of this study were to examine the self-reported attitudes of Brownies and Girl Guides towards science and to evaluate the impact of the Scientist Badge project on their attitudes toward science and their science achievement.

Methods

Description of outreach activities

As part of the Girl Scout programme, Brownies and Girl Guides are community groups that provide young girls with after-school opportunities to participate in games, arts and crafts, and community service with their peers. Brownies range in age from 6 to 9 years, and Girl Guides from 9 to 12 years.

The Scientist Badge programme consisted of ninety minutes of hands-on science activities which were led by more than 130 university undergraduate science student

volunteers, organized into teams of three or four. No teams were composed of only male volunteers, and many were mixed. Initially we believed that all-female volunteer groups might present better role models to the young girls. However, approximately 35 per cent of volunteers were male undergraduate students who were committed to encouraging girls in science. We decided to use some mixed volunteer groups in order to present positive images of women and men working together on scientific activities. The volunteers were trained to lead the activities, and also received advice about effective teaching strategies and management techniques for children of this age. The programme was offered at the regular meeting place of the Brownie or Girl Guide unit for a small charge to help offset the cost of travel and supplies. Most units included two or three adult leaders and about 15–20 girls. Usually each event began and ended with group discussions on such topics as science attitudes, university demands, careers in science, and women in science. In between, smaller groups of girls rotated between a series of activities.

The younger girls in Brownie units participated in three science experiments in the fields of chemistry, physics, and life sciences. Working in groups of 5–7, the girls used the chemical reaction between vinegar and baking soda to inflate a balloon. They also studied balance and centres of gravity. Investigations into hearing and sound were approached from both physical and biological perspectives. The primary purpose of these science activities, which also integrated some artwork, was to increase the girls' confidence in 'doing science' in a fun, non-threatening way.

The older Girl Guides were exposed to activities which demanded more problem-solving and critical thinking abilities. They developed various techniques to separate mixtures and they engineered plasticine boats to examine the principles of density and buoyancy. Each girl also created a newspaper replica of an arm muscle during the life science activity.

Sample construction

During the 1994/95 outreach project, nearly 1500 girls completed Scientist Badge activities in London, Canada, and surrounding area. The city of London has a population of some 300 000 and is located 200 kilometres southwest of Toronto. Of the participating units, 13 Brownie units (approximately 220 girls) and 14 Girl Guide units (approximately 200 girls) were asked to complete a questionnaire which assessed their attitudes towards science and their knowledge of the science which was taught in the Scientist Badge programme (science achievement).

Data collection

Participating units were visited by a member of the research team and asked to complete a questionnaire (pre-test) during a regular unit meeting one week prior to participation in the programme. An identical questionnaire (post-test) was administered one week following completion of the Scientist Badge programme. Some of the younger Brownies who had not yet developed their writing skills did require some assistance in recording their responses. In order to determine their science background, leaders were also asked to complete a short questionnaire.

Measurement of variables

Science attitudes were assessed in two ways with some of the variables adapted from multiple sources. First, the respondents were asked three open-ended questions: 'Describe

what you think a scientist looks like', 'What do you think a scientist does?', and 'What is your definition of the word science?'. Second, a series of statements was presented to which respondents could answer either 'yes' or 'no'. Examples of these statements are 'Science is fun', 'Boys can do science better than girls', and 'I can get hurt doing science'. These questions and variables were the same for Brownies and Girl Guides.

Science achievement was measured using six items related to the three science activities that the Brownies and Girl Guides completed during the Scientist Badge programme. These questions were developed specifically for this study. Respondents were asked to identify the correct answer for each of the six items. The science achievement questions given to the Brownies differed from those given to the Girl Guides, reflecting the fact that the Brownies were involved in different and less complex science activities than the Girl Guides.

Statistical analysis

SPSS/PC+ Version 4 was used to record and analyse data. It was necessary to keep the response categories simple for the young participants and the questions were designed so that the data were at the nominal level of measurement. For example, the questions used to measure attitudes towards science have dichotomous nominal categories, requiring either a 'yes' or a 'no' response. Questions used to measure science achievement had three nominal response categories and were recoded during analysis to create two categories, 'correct' and 'incorrect'. Responses were statistically analysed using 2×2 contingency tables with Yates-corrected chi-squared using $p < 0.05$ as the critical value.

Results

Participation in the Scientist Badge project had a significant impact on the image of a scientist held by all girls, but especially by the older Girl Guides, as shown in Table 1. Before interaction with the undergraduate student volunteers, many girls described a scientist as someone who does experiments while wearing a white lab coat and glasses. Comparing the responses of Brownies and Girl Guides, a similar percentage of Brownies repeated this description in the post-test, while significantly fewer Girl Guides referred to the stereotype after participating in the outreach programme. Instead, more than half of the Girl Guides used the term 'normal or real person' in their description. A smaller, but significant, increase in use of 'normal or real person' was also included in the Brownies' post-test. Surprisingly, few girls specified that a scientist had to be a man even in the pre-test. Perhaps this is a credit to the Girl Scout organization which exposes participants to many different female role models.

Responses to specific statements which were designed to assess attitudes towards science appeared to be age-related and are shown in Table 2. Compared to the Girl Guides, significantly fewer Brownies believed that they will be hurt doing science, and more believed that they should participate in regular science activities during their meetings. Participation in the programme significantly decreased the number of Brownies who believed that 'boys can do science better than girls'. Furthermore, it appears that the girls did relate to the undergraduate student volunteers as scientists because of the significant increase in 'yes' responses to the question 'Do you know a scientist?' in the post-tests.

Of great interest in the attitude questions were the responses to the statement, 'I would be a good scientist'. Nearly twice as many Brownies as Girl Guides responded 'yes' in the pre-test (Table 2). Although the percentage of both groups that responded 'yes' in the post-test increased, those Brownies whose unit leader worked in a science-related occupation

Table 1. Changes in the perception of scientists. Participants responded to several open-ended statements designed to assess their image of scientists. Pre-test questionnaires were completed one week prior to participating in the Scientist Badge programme. Post-test questionnaires were done one week after the programme. *a* denotes significantly different from pre-test at $P < 0.01$; *b* denotes significantly different from pre-test at $P < 0.001$; *c* denotes significantly different from Girl Guides at $P < 0.05$; *d* denotes significantly different from Girl Guides at $P < 0.01$.

	Brownies (6–9 yrs) (% of girls)		Girl Guides (9–12 yrs) (% of girls)	
Terms used to describe a scientist	Pre-test	Post-test	Pre-test	Post-test
Normal or real person	4.0	18.0[b]	29.4	56.3[b]
White lab coat	52.4	54.4	66.1	39.3[b]
Glasses or goggles	36.1[d]	32.O[c]	45.4	23.5[b]
Does experiments	36.1[d]	36.4[d]	53.7	52.5

Table 2. Changes in attitudes towards science. Participants responded to several yes/no statements which were designed to assess their attitude towards science. Pre-test questionnaires were completed one week prior to participating in the Scientist Badge programme. Post-test questionnaires were done one week after the programme. *a* denotes significantly different from pre-test at $P < 0.01$; *b* denotes significantly different from pre-test at $P < 0.001$; *c* denotes significantly different from Girl Guides at $P < 0.05$; *d* denotes significantly different from Girl Guides at $P < 0.01$.

	Brownies (6–9 yrs) % girls responding 'Yes'		Girl Guides (9–12 yrs) % girls responding 'Yes'	
Statement	Pre-test	Post-test	Pre-test	Post-test
I would be a good scientist.	74.7[d]	80.9[d]	42.1	47.4
I could get hurt doing science.	60.3[d]	64.3[d]	72.8	78.3
Science should be a regular activity for Brownies and Girl Guides	79.7[c]	81.8[d]	68.9	68.0
Boys can do science better than girls.	12.2	5.0[a]	4.2	3.8
Science is fun.	94.1	97.3	96.7	92.8
Do you know a scientist?	32.4	52.7[b]	33.8	55.2[b]

appeared to have the greatest increase (67.9 per cent answered 'yes' in pre-test against 82.6 per cent in post-test, $p < 0.05$). Significantly fewer of the older girls continued to believe that they would be good scientists. Results from this statement were further examined by age and are shown in Figure 1. There appears to be a steady decrease in confidence in scientific ability, with obvious drops at ages 8 and 10.

With respect to scientific achievement as measured by a series of science questions, there was a significant increase in the number of correct responses given to all but one question for both Brownies and Girl Guides (Tables 3 and 4). One question given to the Girl Guides was removed upon analysis by the authors because it was deemed confusing. Table 5 shows the profile of Brownie and Girl Guide leaders whose units completed the questionnaire. It appears that the majority of Brownie and Girl Guide leaders have completed at least some optional high-school courses in mathematics, biology, and chemistry, and nearly half have completed grade 11 physics. Moreover, 21 per cent of the leaders reported working in a science-related field.

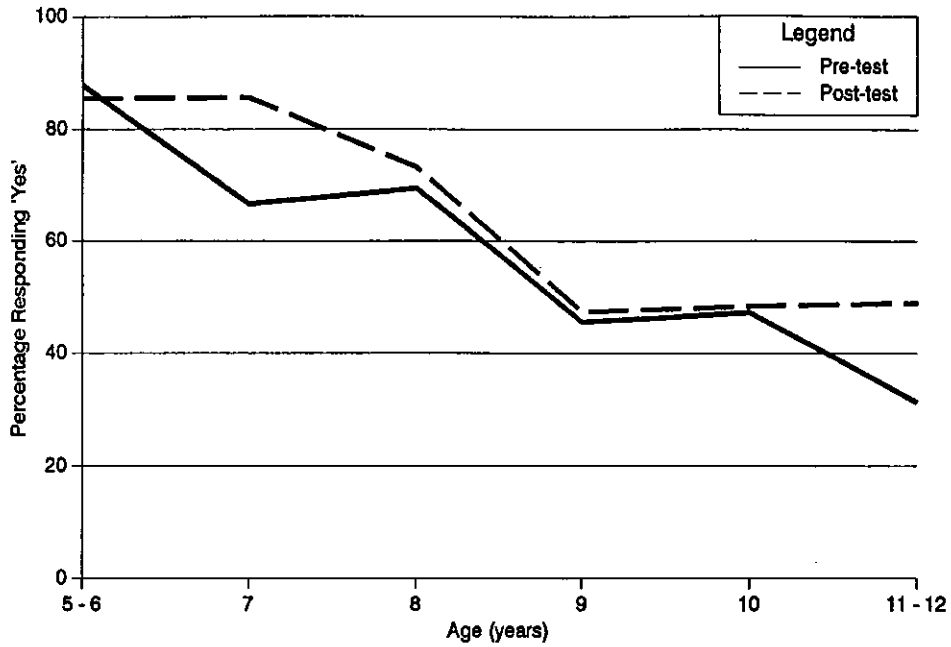

Figure 1. Relationship of age to science attitude. Responses to the statement 'I would be a good scientist' shown in Table 1 were replotted against the age of participants.

Discussion

The science outreach programme developed by Let's Talk Science appeared to be effective in altering the perception of science and scientists which was held by many young girls participating in Brownie and Girl Guide programmes. When asked to describe a scientist one week prior to participating in the programme, the majority of girls described a stereotypical character who conducts experiments while wearing a white lab coat and safety glasses. However, after spending 90 minutes with the undergraduate student volunteers who led the science activities, there was a significant increase in their use of the term 'normal or real person' in response to the same question. The image held by older girls in Girl Guide units was altered to the greatest extent, suggesting that a small amount of time spent by volunteers in an organized programme can have a significant effect on a population of girls (aged 9–12) which is at serious risk of avoiding science.

The participants' perceptions were likely altered by their interaction with the undergraduate student volunteers, whom the girls appeared to equate with 'real' scientists even though they were quite young (aged 19–22), in contrast to suggestions of Koballa.[14] Because the volunteer groups were either all-female or mixed, the Brownies and Girl Guides witnessed young women confidently doing science and interacting equally with male colleagues. This appeared to affect the Girl Guides more than the Brownies, and we saw a decline in their use of masculine descriptions of scientists. Although many more girls did specify male scientists than female scientists, we were surprised that fewer than 15 per cent of those surveyed actually volunteered a masculine image. Instead, most respondents wrote 'a person' or just described the clothing worn or equipment used by scientists.

The use of crazy, white-haired men to portray scientists pervades the media and has

Table 3. Changes in Brownies' achievement in science. Brownies achieved higher scores on the science questions one week after participating in the Scientist Badge programme (post-test) compared to one week before the programme (pre-test). * indicates the correct response. *a* denotes significantly different from pre-test at $P < 0.01$. *b* denotes significantly different from pre-test at $P < 0.001$.

	Brownies (6–9 yr) % correct responses	
Science question	Pre-test	Post-test
Which will cause a chemical reaction? (a) mixing salt and water (b) mixing vinegar and baking soda* (c) mixing sand and sugar	73.3	90.1[b]
What happens when you mix vinegar and baking soda? (a) nothing (b) it turns yellow (c) it makes a gas*	69.2	86.3[b]
Where is the centre of gravity on an empty pop bottle? (a) at the top of the bottle (b) at the bottom of the bottle (c) at the middle of the bottle*	36.3	66.7[b]
Where is the centre of gravity on your body? (a) at your belly button* (b) at your nose (c) at your knees	42.0	76.1[b]
Why do your ears stick out of your head? (a) to protect the inside of your ear (b) to act like a funnel for sound* (c) to hang earrings on	39.5	52.7[a]
How do we hear noises? (a) vibrations in the air* (b) changes in the wind (c) we feel them	58.1	75.7[b]

strongly influenced young people's understanding of science. In addition to the lab-coat- and goggle-wearing man, the typical scientist is usually depicted as an evil, lone, crazy character consumed by a desire to manipulate the world in his single-minded pursuit of science. Interestingly, this portrayal of destruction was rarely given by girls in the current study. Similarly, Fort and Varney found that most young students actually believe that scientists are positive, even benevolent people.[15] A problem with our use of the general, open-ended question 'What does a scientist look like?' to assess attitudes towards science has been reported by others. Boylan and colleagues found that the use of such questions, or the nonspecific command 'Draw a scientist', usually elicits descriptions which do closely resemble the stereotype, even when given by professional scientists.[16] This is likely the result of the universally-accepted image of an Einstein-type character or goggle-wearing chemist. Similarly, if we were to ask participants to describe or draw a farmer, we might

Table 4. Changes in Girl Guides' achievement in science. Girl Guides achieved higher scores on most science questions one week after participating in the Scientist Badge programme (post-test) compared to one week before the programme (pre-test). * indicates the correct response. *a* denotes significantly different from pre-test at $P < 0.01$. *b* denotes significantly different from pre-test at $P < 0.001$.

	Girl Guides (9–12 yr) % correct responses	
Science question	Pre-test	Post-test
How would you separate sugar from sand if they were mixed together? (a) add water to dissolve the sugar, and then pour liquid off, leaving sand* (b) use a magnet to pull sand away from sugar (c) add water to make the sand into mud, then pour off the mud, leaving the sugar	58.7	77.0[b]
Which of the following is a mixture? (a) vinegar and baking soda (b) cookie (c) tossed salad*	10.4	25.1[b]
What is density? (a) the amount an object weighs compared to the amount of space it takes up* (b) it refers to the colour of an object (c) it is a scientific word for 'movement'	55.5	71.7[b]
Which of the following statements describe how muscles do work? (a) muscles contract (get shorter)* (b) muscles expand (get longer) (c) muscles contract or expand depending on the work they are doing	1.9	14.0[b]
What attaches a muscle to a bone? (a) blood vessels (b) nothing, the muscle attaches directly to the bone (c) tendons (strong fibres)*	64.2	69.4

expect to see overalls and a tractor because it is convenient to refer to a stereotypic image for ease of communication. However, in spite of drawing stereotypical scientists, Boylan's study also found that even young children can hold an informed view of the scientific enterprise.[16]

Interestingly, we found that the girls appeared to be concerned about a perceived danger associated with science. The statement 'I can get hurt doing science' was added because of our personal experiences with several girls who have been hesitant to try supervised scientific activities in which they believed they could be hurt. Although nearly 70 per cent of the girls felt that science activities should be done regularly at their meetings, a similarly high percentage believed that they could be hurt while doing science. This feeling appeared to strengthen with age. The reasons for their concern were not clear but may be affected by increasing exposure to television or movies that portray a destructive image of science.

Table 5. Science background of unit leaders. Brownie and Girl Guide leaders completed a survey of their science background before participating in the Scientist Badge programme. Percentage of leaders are shown in brackets.

	Brownie Unit leaders	Girl Guide Unit leaders
Number of leaders surveyed	34	48
Average age	36 + 2	39 + 2
Average time as leader	4.8 + 1.2 years	5 + 0.8 years
Main occupation in science-related field	7 (21%)	10 (21%)
Completed grade 11 Biology (or higher)	22 (65%)	27 (56%)
Completed grade 12 Chemistry (or higher)	19 (56%)	27 (56%)
Completed grade 11 Physics (or higher)	16 (47%)	23 (48%)
Completed grade 11 Mathematics (or higher)	29 (85%)	37 (77%)

Unfortunately, this feeling of danger was not alleviated by their experiences in the outreach programme and more consistent exposure to science may be required to lessen their fears. It is also possible that the girls did not equate their informal experience with a 'typical' scientific experiment since it occurred outside a formal classroom, possibly resulting in a decreased feeling of safety.

More than 90 per cent of those surveyed in the present study responded positively to the statement 'Science is fun' before participating in the Scientist Badge programme. This overwhelmingly positive attitude by young girls towards science has been found by others. Indeed, Levine and Ornstein have found that few or no gender differences in attitudes are apparent until puberty.[17] After this time, however, many girls do lose interest in science for a variety of reasons, perhaps the most important being their experiences in the formal classroom. At this time they begin to describe science classes as 'facts to memorize' and 'boring'.[18] These feelings may be the result of different treatment by teachers and laboratory experiences that differ from male students in their science classes.[19] Additionally, a masculine image of science is often presented in the classroom, perhaps suggesting to girls that they are less capable of pursuing science successfully. These messages will lead to a decline in the confidence and desire of girls to study and enjoy science. Indeed, social experiences and opportunity are likely the key to differential participation in science.

Findings in the present study suggested that confidence in science ability may be an age-related trait. In response to the statement 'I would be a good scientist', the frequency of 'yes' responses decreased significantly with age. Interestingly, those Brownies whose leaders worked in science-related fields responded most positively to this statement after the activities. There appeared to be no such relationship between the responses of older Girl Guides and their leaders' occupation. Although the Girl Guides lacked confidence in their own scientific abilities, few believed that boys could do science better than girls, and there was significant improvement in their own science achievement as demonstrated by responses to the post-test questionnaire.

It is unlikely that the girls' level of confidence in science is solely dependent on age, but rather depends on experience or opportunity. Few young girls are encouraged to pursue scientific and practical experiences of educational value. For example, boys tend to receive building blocks, chemistry sets and telescopes while girls often receive dolls and toy houses. Therefore, girls often lack hands-on expertise when they reach the classroom and may, understandably, be less confident about their scientific abilities.

The image of scientists appeared to be altered to the greatest extent with the Girl Guides, but science achievement improved most with the Brownies. The number of correct

responses to the scientific questions posed to participants was significantly increased in the post-test, suggesting that the level of the hands-on activities was appropriate for their ages. Surprisingly well answered on the pre-test were questions about the chemical reaction between vinegar and baking soda. This finding may be explained by the common use of this visually impressive demonstration on televised children's science shows.

Working with community-based girls' clubs, such as Brownies and Girl Guides, provides an excellent forum for outreach science activities. Unlike the school classroom, attendance to meetings is voluntary and the visiting scientist is usually greeted with the full cooperation of participants. Organizations such as these provide girls with opportunities to participate in new activities in a non-threatening environment, and thereby acquire skills which will serve them well in the formal classroom and beyond. Since achievement in science seems to be most strongly correlated with measures of science confidence and attitude toward science,[5] it seems reasonable to believe that increased exposure to science in informal settings can improve future achievement in science. In support of this, the current study demonstrated that a small effort by scientists can have a significant impact on both science achievement and on the attitude towards science of young girls. It is also clear that to improve the confidence of 9–12 year-old girls, even more effort is required and will require increased exposure of this audience to science.

If it really is so easy to influence science attitudes, a strong predictor of future science achievement, by increasing the exposure of girls to scientific activities, then why isn't more being done? We found that about 20 per cent of the leaders were employed in scientific careers, but that this appeared to affect only the Brownies' attitudes towards science. The apparent lack of effect of leaders' science experience upon the attitude of older Girl Guides should be explored more fully, in a longer-term study. Although the majority of leaders had completed grade 11 science or higher (several have completed some post-secondary science education), few reported leading science activities with their units or discussing the scientific principles associated with other activities. This may be attributed to the leaders' own lack of science awareness. Indeed, many leaders described feelings of discomfort regarding teaching science to their units. However, much of the Brownies' and Girl Guides' programming does highlight science through issues of environmental awareness and conservation. Many professional scientists are also reluctant to teach science to young students. Some are busy with their own research, while others are uncomfortable being with a young audience. It has been our experience, however, that once a scientist has spent an hour in the company of these enthusiastic, curious, young people, they are convinced of the need for their participation and usually continue to volunteer.

We have found that undergraduate students who major in science are excellent volunteers for the Scientist Badge programme for a variety of reasons. First, the evening meeting times are very convenient for volunteers who spend their own day in classrooms. Second, because of the relatively small difference in age most volunteers feel quite comfortable with the young audience. Third, the activities are fun and the girls' enthusiasm is contagious. According to many volunteers, this excitement often reinforces why they chose to pursue science themselves. Fourth, the volunteers develop a sense of community responsibility. This awareness of public accountability is essential for future scientists and may be as important as increasing the science interest and achievement of young girls.

In summary, the current study found that a one-time interaction between university undergraduate student volunteers and young girls can significantly improve participants' attitudes towards science and achievement in science. However, additional positive experiences in science are essential to increase the confidence of this young audience which is at serious risk of avoiding science.

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Appendix: Survey Questions

A. Survey questions on attitudes towards science given to Brownies and Girl Guides

Questions assessing achievement appear in Results.

(1) Describe what you think a scientist looks like.
(2) What do you think a scientist does?
(3) What is your definition of the word 'science'?
(4) Do you agree with the following statements (yes or no)?

Science should be a regular activity for Brownies/Girl Guides.
Science is fun.
Boys can do science better than girls.
Girls can do science better than boys.
Everybody should know something about science.
Only boys should take science in high school or university.
Both boys and girls should take science in high school or university.
Only girls should take science in high school or university.
I would be a good scientist.
I can get hurt doing science.

(5) What do you want to be when you grow up?
(6) Do you know a scientist? If yes, who?

B. Questions given to unit leaders

The percentage of leaders who responded to questions that are not discussed in the text are shown in parentheses.

(1) Do you think it is important for children to learn science?
   (a) yes (100%)
   (b) no

   Why? (curiosity—18%, understanding their world—64%, develops mind—18%)
(2) At what age do you think a child should begin to learn about science?

	Pre	Post
< 1	3	14
1	14	11
2	15	14
3	9	14
4	18	14
5	24	8

(3) Do you agree that children should be involved in science activities during Brownie or Girl Guide meetings?

	Pre	Post
(a) agree strongly	35	38
(b) agree	56	56
(c) neither agree nor disagree	9	5
(d) disagree		
(e) disagree strongly		

Why?

(4) How often do you deliberately include science activities in your unit's programmes?
   (a) almost every meeting (3)
   (b) several times each month
   (c) about once a month (29)
   (d) a few times during the year (58)
   (e) never or almost never (10)

(5) In what form(s) have you incorporated science into your programmes?
   (a) guest speakers (50)
   (b) field trips (62)
   (c) health/fitness activities (38)
   (d) arts and crafts (62)
   (e) environmental awareness activities (65)
   (f) Are there other ways in which you incorporate science into your programme?

(6) How do you choose science activities for your unit?

(7) Why did you request to participate in the 'Scientist Badge Project' and what do you expect to gain from the programme?

(8) How long have you been a leader?

(9) What is your usual occupation?

(10) What is the highest level of science education that you have completed? Biology, Chemistry, Physics, Mathematics:
   (a) high school: grade 10
   (b) high school: grade 11
   (c) high school: grade 12
   (d) high school: grade 13
   (e) college
   (f) university
   (g) other
   (h) no training

In the post-test the following questions were also included:

(1) Please evaluate the presenters who visited your unit to lead Scientist Badge activities using the following scale: 1 = Low, 5 = High (percentage responding 4 or 5)
   (a) knowledge level of presenters (100)
   (b) ability to answer questions (100)
   (c) ability to communicate science (97)
   (d) overall effectiveness of presentation (100)
   (e) interest level of Brownies/Girl Guides (97)
   (f) interaction between girls and presenters (98)
   (g) length of presentation (3 = appropriate)
   (h) level of difficulty of presentation (3 = appropriate)

(2) In your opinion, please rate the Scientist Badge Project with respect to enjoyment and science education for your unit.

(a) excellent, everyone learned something new about science (78)
(b) good, most of us enjoyed the event (19)
(c) OK (3)
(d) needs improvement
(e) not good

Please comment.

(3) Did the Let's Talk Science volunteers alter your perception of a scientist?

(a) yes (33)
(b) no (67)

(4) How did the 'Scientist Badge' activities alter your perception of science activities?

(a) made science and technology activities seem easier than I had thought (35)
(b) did not alter my perception (65)
(c) made science and technology activities seem more difficult than I had thought.

Please explain.

(5) Are you more likely to lead science activities on your own, after participating in the Scientist Badge Project?

(a) yes (60)
(b) no (40)

Why?

(6) How did the Scientist Badge project affect your confidence in your own ability to lead science activities with your unit?

(a) increased my confidence (51)
(b) no effect (49)
(c) decreased my confidence

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Authors

Bonnie Schmidt is Director of the Let's Talk Science programme based at the University of Western Ontario. She holds a PhD in Physiology, but is currently interested in understanding how outreach programmes affect science learning in preschool, elementary, and high school students and teachers. Dr Schmidt can be reached at the Health Sciences Addition, University of Western Ontario, London, Ontario, Canada N6A 5C1 or by email at bschmidt@do.med.uwo.ca.

Richard Mark Nixon is a Research Assistant with the Let's Talk Science programme. He holds an MA in sociology and is a certified elementary school teacher in Ontario.