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Effectiveness of Amateur Astronomers as Informal Science Educators

by **Michael G. Gibbs**

Astronomical Society of the Pacific

Margaret Berendsen

Astronomical Society of the Pacific

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Abstract

The Astronomical Society of the Pacific (ASP) conducted a national survey of in-service teachers participating in Project ASTRO. The survey results document (1) the value that teachers place on supplemental astronomy education provided by professional and amateur astronomers, and (2) the difference that teachers perceive in the value provided by professional astronomers versus amateur astronomers. Survey participants indicated that they believe that the astronomer partner positively influenced students' attitudes toward science and that amateurs may be especially effective at the elementary school level. The results also indicate that as volunteer educators, amateurs are perceived to be at least as effective as professionals when partnered with teachers in the classroom.

1. INTRODUCTION

Many amateur astronomers regularly serve their communities as informal astronomy educators. From prior studies, we know the profile of amateur astronomers, the kind of outreach that they do, and the frequency of that outreach (Storksdieck et al. 2002). We have research indicating a high level of astronomy knowledge among experienced amateur astronomers who do outreach (Berendsen 2005). As Bailey and Slater (2003) indicated, research in astronomy education is a new field; therefore, the literature regarding involvement of amateur astronomers in science learning is limited. Astronomy is in the unique position of having a large community of knowledgeable nonprofessional enthusiasts from which to draw (Berendsen).

Little or no research exists on the effectiveness of amateur astronomers as astronomy educators. This article investigates the value, from the teachers' perspective, of amateur astronomers as compared with professional astronomers for school astronomy education. The two primary goals of this study are (1) to document the value that teachers place on supplemental astronomy education provided by professional and amateur astronomers, and (2) the difference that teachers perceive in the value provided by professional astronomers versus amateur astronomers. In their review of the National Science Education Standards, Adams and Slater (2000) indicated that in several instances, astronomy and space science concepts are included as important components of a student's science education. But, despite the inclusion of astronomy and space science in educational standards for primary and secondary students, most students are learning very little astronomy (Nelson 2004).

Astronomy is a part of the learning standards in many states and is included in the National Science Education Standards. However, astronomy is not fully used within the learning process, nor as a possible key to unlock students' potential (Percy 1995). Astronomy is not more effectively used within the science curriculum for several reasons (Percy):

1. Few teachers, especially at the elementary level, have any training in astronomy.
2. Teachers think that astronomy must be technical and mathematical and that it requires elaborate teaching equipment.
3. Simple, inexpensive "hands-on" activities are needed, preferably ones that get around the problem that "the stars come out at night, the students don't."
4. Inappropriate teaching techniques fail to address students' ingrained misconceptions about physical and astronomical phenomena.

Nelson (2004) concluded that for astronomy learning to take place, teachers must either have sufficient background knowledge themselves or receive outside support (for instance, by inviting experts as guest instructors into their classrooms). One possible method to begin the process of overcoming the lack of astronomy education is through collaboration. Wheelock (2000) stated that in middle schools across the nation, teachers often have formal and informal collaborations with specialists to improve the learning process.

The amateur astronomy community is regularly engaged in volunteer projects in which amateur astronomers share their knowledge of astronomy, thereby serving as informal educators (Storksdieck et al. 2002). The activity of sharing knowledge and being engaged in the learning process has come to be known as education and public outreach (EPO) (Cooper et al. 2004). There are considerably fewer professional astronomers than amateur astronomers in the United States. Berendsen (2005) showed that amateur astronomers seem to know their astronomy, alleviating the fear that they may not provide correct content. But are teachers satisfied with amateur astronomers in the classroom, and do they find significant value in their contributions? This study investigates differences in teachers' perceptions of the value of professional and amateur astronomers who volunteer in the classroom through a program called Project ASTRO.

Established by the Astronomical Society of the Pacific (ASP) in 1993, Project ASTRO is a program that creates a year-long partnership between an in-service teacher and a volunteer astronomer (Fraknoi 2000). The volunteer astronomer, either a professional or amateur, commits to enriching students' learning experiences through engaging in hands-on science learning activities. The volunteer astronomer is selected by the ASP through a written application, telephone interview, prior experience in explaining astronomy

to students and/or the public, and a commitment to working with the teacher for the academic year (Note 1). Together, educator and astronomer participate in a two-day summer workshop, receive fully tested astronomy resource materials such as *The Universe at Your Fingertips* (Fraknoi 1995), and develop a strategy for working together in and out of the classroom. The astronomer/teacher partnership team agrees to participate in a minimum of four sessions with students during the school year.

2. METHODOLOGY

In the spring of 2006, a 23-item survey developed by the ASP, in consultation with the Institute for Learning Innovation, was distributed to in-service teachers participating in Project ASTRO (see Appendix A). In the San Francisco Bay Area, in-service teachers received a letter in the mail asking them to either complete the survey online or fill out the survey and return it in a postage-paid envelope. Nationally, the organizations working with the ASP that operate a Project ASTRO program were invited to participate in this study. The national partners contacted their in-service teachers via e-mail and asked them to complete the survey online. All in-service teachers completed the same survey. A list of the eight participating Project ASTRO sites can be found in Appendix B.

As incentive, participants who did not wish to remain anonymous could enter a prize drawing for completing the survey. Following the survey, the six ASTRO sites with at least five respondents who identified themselves were contacted. The ASTRO site leaders were asked to report whether the teacher's astronomer partner self-identified as a professional astronomer, an amateur astronomer, a student, or other educator.

There are two primary limitations to this study in the area of sample bias that stem from the total response rate of 33% ($n = 177$). The low response rate does not guarantee a representative sample because it is somewhat more likely that teachers with positive experiences (or very negative ones) would respond. Second, this was an optional study, and only 8 of 14 Project ASTRO sites participated. Possible sample bias therefore limits what we can conclude about overall teacher satisfaction with the project and the value that teachers place on their astronomy partners as a whole. However, assuming that similar bias exists between teachers who were paired with a professional astronomer and those who were paired with an amateur astronomer (and the response rates for both were similar), we can reasonably compare the teacher responses between those two groups of partners.

3. RESULTS

To evaluate how in-service teachers perceive their astronomer partners, respondents were asked to rate

- their most recent overall experience working with a Project ASTRO astronomer;
- the level of assistance provided to them by the astronomer; and
- their overall level of satisfaction with their relationship with the astronomer.

To determine the teachers' perspectives on whether the astronomer partner influenced their students in any perceptible way, teachers were asked to provide their opinions on

- to what degree the project changed their students' attitudes toward science, and
- to what degree the project was able to correct some common student misconceptions in astronomy or science in general.

The survey did not measure directly (i.e., through some form of a test) whether and to what degree the project changed student knowledge and attitudes, but instead focused on teacher perception because teachers are important decision makers and gatekeepers. The focus was on teacher perception, not student performance. The teachers' perceptions served as an indicator of how effective they felt the assistance of the astronomer partner was within their classroom.

To determine if school level made any difference in the partnership's perceived effectiveness, we analyzed the responses based on level taught: elementary school (third through fifth grade) or middle/high school (sixth through ninth grade).

3.1 Survey Results by Partner Type and School Level

To determine the perceived effectiveness of amateur astronomers as compared with professional astronomers, we requested six of the ASTRO site leaders to report what type of astronomer partner each known teacher was assigned to. Of the 119 identified partners, 61% self-identified as amateur astronomers, 22% as professionals, 10% as students, and 7% as other educators. This closely matches the national percentages provided to us by the national coordinator for Project ASTRO (Dan Zevin, personal communication 2006). Of the 491 ASTRO partnerships in the 2005–2006 school year, 55% of teachers were with amateur astronomers, 26% were with professional astronomers, 11% were with students, and 8% were with educators (see Table 1).

Table 1. Distribution of Astronomer Partner Types		
Astronomer partner type	This survey	National Project ASTRO
Amateur astronomer (<i>n</i> = 73)	61%	55%
Professional astronomer (<i>n</i> = 26)	22%	26%
Student (<i>n</i> = 12)	10%	11%
Other educator (<i>n</i> = 8)	7%	8%

For the purpose of this study, only the comparisons between amateur and professional astronomers were considered. The "student" and "other educator" categories were not used in these comparisons. Based on the results in Table 1, teachers partnered with amateurs were as likely to respond to the survey as teachers who partnered with professionals.

Project ASTRO operates in grades 3–9. Of the 139 survey respondents who clearly identified the school level taught, 50% taught elementary (third through fifth grade) and 50% taught middle or high school (sixth through ninth grade).

Those 73 teachers who partnered with amateur astronomers (see Figure 1) expressed similar levels of satisfaction as those 26 teachers who partnered with professionals (see Figure 2).

Regarding the type of astronomer partner, the teachers' responses to the question about perceived change in student attitude toward science were used to determine if the amateur astronomer partner was seen as being at least as effective as a professional astronomer (see Table 2; "slight positive change" and "no change" were collapsed because we are only interested in significant perceived change).

Sixty percent of those teachers partnered with an amateur astronomer reported that they saw a "large positive change" in student attitudes, compared with 46% of those who partnered with a professional astronomer. The difference between amateurs and professionals was not significant ($X^2=1.56, p = 0.21$). Amateurs and professionals were perceived by teachers to be equally effective partners in changing student attitudes.

Table 2. Student Change in Attitude by Astronomer Partner Type		
Teacher's perceived change in student attitude toward science	Amateur partner (<i>n</i> = 73)	Professional partner (<i>n</i> = 26)
Large positive change	60%	46%
Slight positive or no change	40%	54%
Negative change	0%	0%

Satisfaction with Amateur Astronomer Partner (N=73)

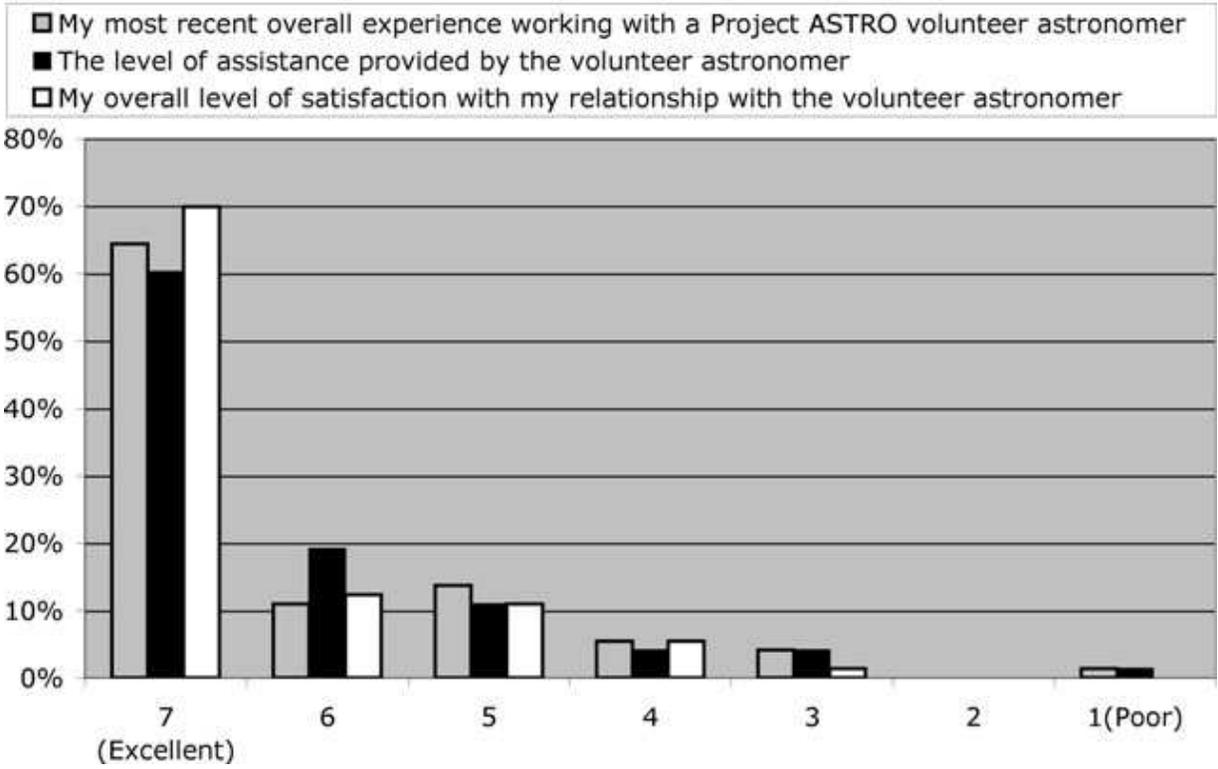


Figure 1. Satisfaction with Amateur Astronomer Partner

Satisfaction with Professional Astronomer Partner (n=26)

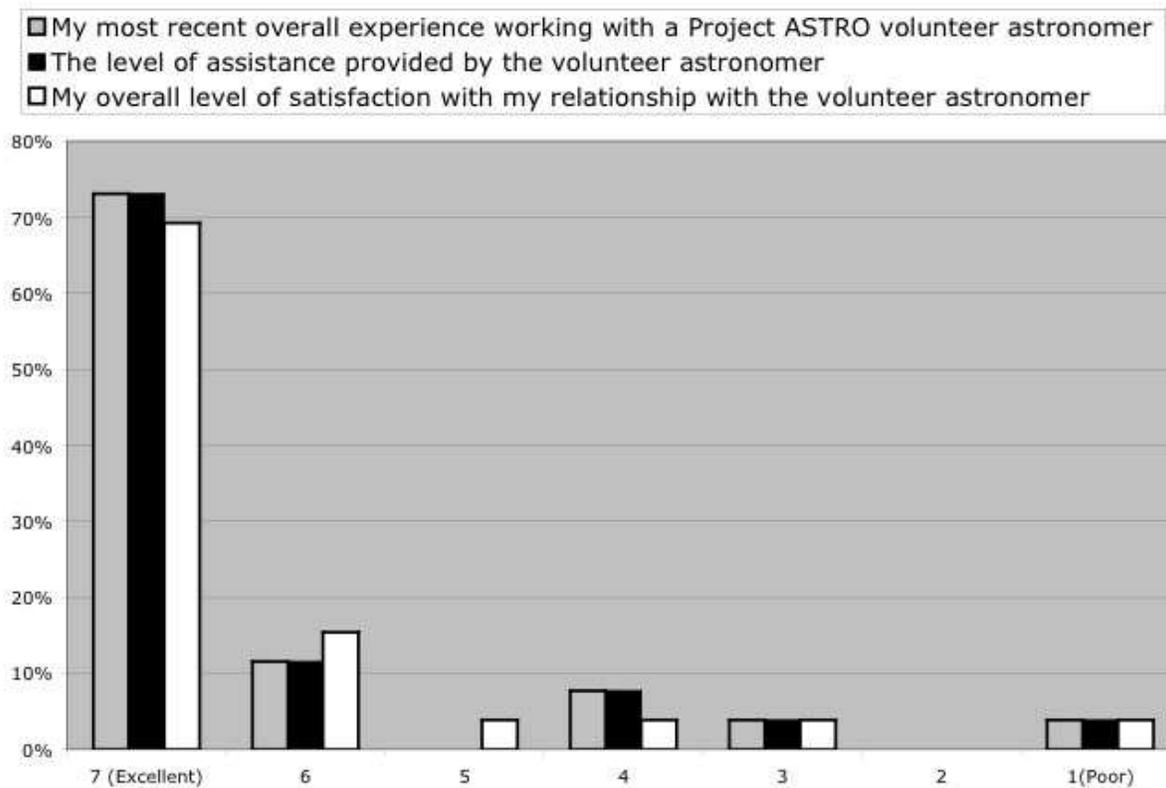


Figure 2. Satisfaction with Professional Astronomer Partner

The 70 elementary teachers (see Figure 3) expressed similar levels of satisfaction with the program as the 69 middle to high school teachers (see Figure 4).

Regarding school level, the teachers' responses to the question about perceived change in student attitudes toward science were used to determine if elementary students were seen as being influenced by the program as much as middle and high school students were (see Table 3; as in Table 2, "slight positive change" and "no change" were collapsed because we are only interested in significant perceived change).

Seventy percent of elementary teachers perceived positive changes in their students' attitudes toward science as a result of the project, in contrast to 36% of those teaching middle or high school ($X^2 = 16.0, p < 0.001$). Elementary students were perceived by teachers as having a greater change in attitude toward science than middle and high school students as a result of the Project ASTRO program.

Table 3. Perceived Student Change in Attitude by School Level		
Teacher's perceived change in student attitude toward science	Elementary (n = 70)	Middle/high (n = 69)
Large positive change	70%	36%
Slight positive or no change	30%	64%
Negative change	0%	0%

Elementary School Teachers (n=70)

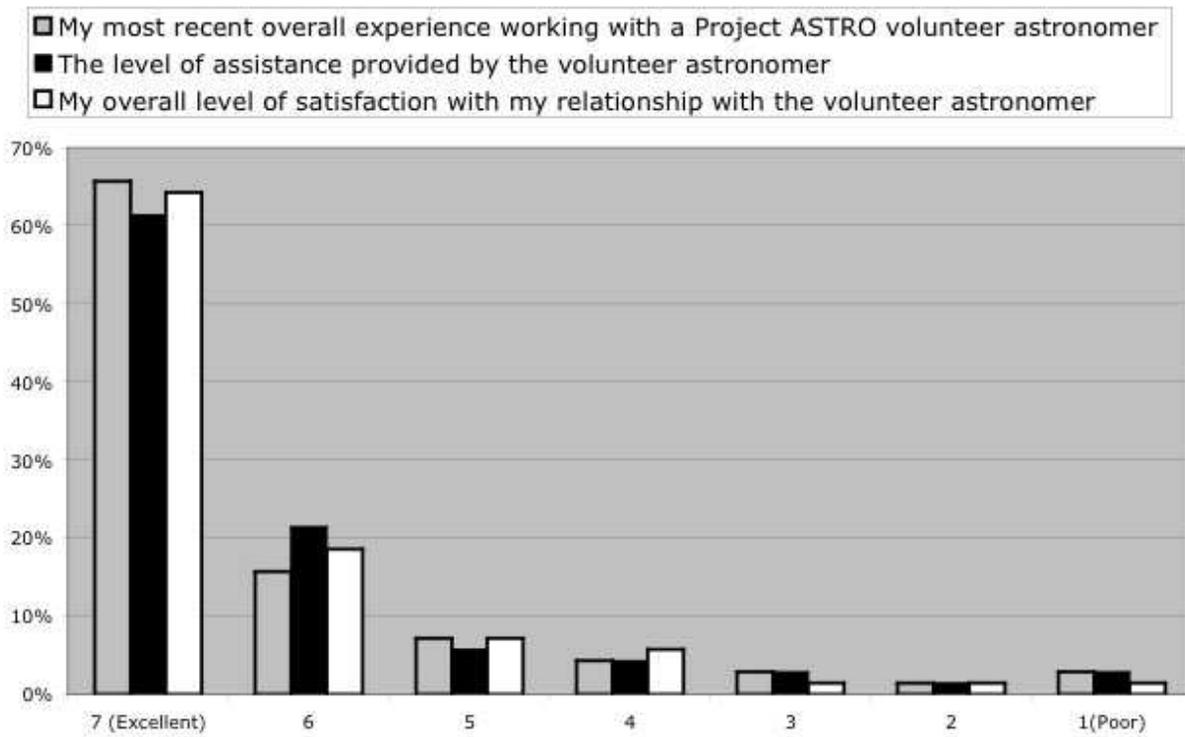


Figure 3. Satisfaction with Project ASTRO Program by Elementary School Teachers

Middle/High School Teachers (n=69)

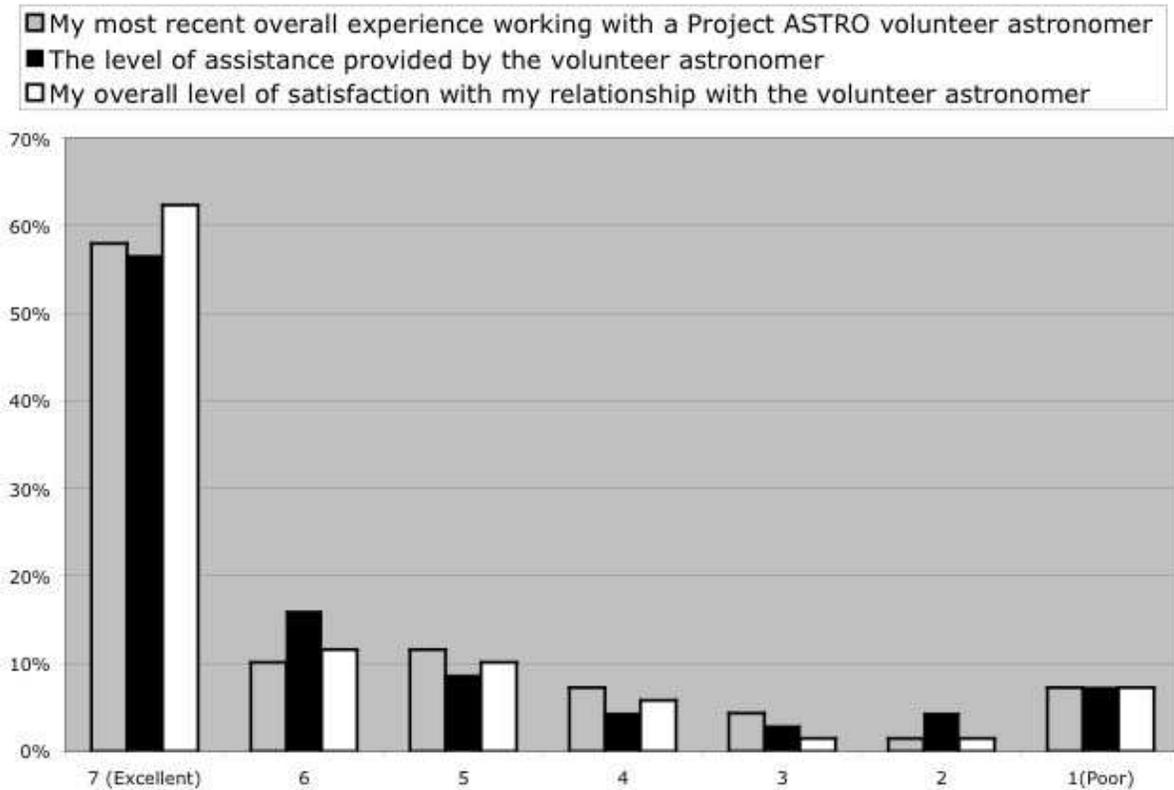


Figure 4. Satisfaction with Project ASTRO Program by Middle/High School Teachers

The perceived student change in attitude toward science was linked to school level and whether an amateur or a professional astronomer was partnered with the teacher (Table 4). Although almost twice as many elementary teachers as middle/high school teachers reported a perceived large positive effect when they partnered with an amateur astronomer ($X^2 = 11.8, p < 0.01$), no real difference occurred when the partnership was with a professional astronomer.

Teacher's perceived change in student attitude toward science	Amateur partner		Professional partner	
	Elementary (n = 39)	Middle/high (n = 33)	Elementary (n = 12)	Middle/high (n = 14)
Large positive change	77%	39%	50%	43%
Slight positive or no change	23%	61%	50%	57%

To further test differences in the perceived effectiveness of amateur and professional astronomers as classroom partners, we compared teachers' perceptions of the degree to which the program was able to correct student misconceptions. We collapsed again some of the forced-choice categories but were primarily interested in the percentage of teachers who saw strong effects of the program. There was no difference in teachers' responses by type of astronomy partner (Table 5). Fifty-three percent of those teachers partnered with an amateur astronomer and 46% of those partnered with a professional astronomer perceived strong positive effects on student misconceptions ($X^2 = 0.95, p = 0.62$). In the eyes of teachers, amateurs and professional astronomers appeared equally effective in addressing astronomy misconceptions in students.

Perceived correction of student misconceptions	Amateur partner (n = 73)	Professional partner (n = 26)
Very much	53%	46%
Somewhat	36%	46%
Not sure/not really/certainly not	11%	8%

There was no relationship between school level and whether teachers believed that the astronomy partner was able to address misconceptions: 56% elementary teachers and 42% of middle and high school teachers believed that the program was able to address student misconceptions "very much" ($X^2=3.26, p = 0.20$).

Table 6. Perceived Correction of Student Misconceptions by School Level		
Perceived correction of student misconceptions	Elementary (<i>n</i> = 70)	Middle/high (<i>n</i> = 69)
Very much	56%	42%
Somewhat	34%	49%
Not sure/not really/certainly not	10%	9%

4. DISCUSSION AND CONCLUSIONS

This study examines in-service teachers' experiences with astronomers within a classroom setting and provides preliminary results on the perceived effectiveness for both amateurs and professionals. There are several times more amateur astronomers among the American public than there are professional astronomers (Fraknoi 1996). If, as the results indicate, the amateurs' effectiveness is at least as great as the professionals, amateurs represent a large potential reservoir to assist science educators.

The results, shown in Figures 1–4, suggest that teacher satisfaction with an astronomer partner was generally quite high, regardless of whether the partner was an amateur or a professional. This indicates the amateur astronomers' ability to effectively collaborate with teachers to provide value in the classroom. Not only are experienced amateur astronomers almost as knowledgeable as professionals in basic astronomy concepts (Berendsen 2005), but they are also perceived by teachers to be at least as effective as professionals in the classroom.

As indicated in Table 4, the results show that amateur astronomers may be more effective in influencing the attitudes of younger students than influencing attitudes of teenage students. This may mean that amateur astronomers are particularly suited to positively influencing attitudes about astronomy and science among elementary school-age children. Amateurs may show more enthusiasm than professionals, an enthusiasm that younger, more spontaneous students may more readily adopt than older, more reserved students. It is also possible that amateurs are more effective with the younger students than are professionals. Perhaps amateurs are more likely to use language and examples that are easier for students to understand, but additional research is needed.

The data results indicate that amateur astronomers are particularly valued for their knowledge of astronomy and their ability to inspire interest in science. Because public outreach is defined as inspiring the general public to increase their knowledge regarding science through informal educational experiences, this study provides preliminary evidence that amateur astronomers are at least as effective as professional astronomers in inspiring interest in science. The results also show that amateur and professional astronomers were perceived to be comparable in their ability to correct students' misconceptions regarding science through the Project ASTRO program.

Amateur astronomers use a number of methods to engage in education and public outreach beyond the classroom, such as participating in star parties, at science centers, in after-school programs, and with youth groups. This study provides additional evidence of the value of amateur astronomers as volunteer

astronomy educators. To test actual learning outcomes such as those measured by standardized testing would require a different study. It would also be instructive to gather and analyze data on the responses of general audience members at other venues where amateur astronomers do outreach as to their effectiveness in positively influencing the public's attitudes about and understanding of astronomy and science. Additional research could also be conducted by directly surveying the students who participate in Project ASTRO. These courses of inquiry would provide data directly from the participants.

Note 1: ASP Web Page for Bay Area Project ASTRO:

<http://www.astrosociety.org/education/astro/bayarea/volunteer.html>

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Appendix A

Click here for the Project ASTRO Teacher Survey Spring 2006 in PDF format. [URL:
<http://aer.noao.edu/auth/gibbsAppendixA.pdf>

Appendix B

National Project ASTRO Teacher Survey—Participating Network Members, Spring 2006

Boston
Colorado
Connecticut
New Jersey
Ohio
San Francisco
Seattle
Tucson