panorama
Human Centered Innovation

Skynet Junior Scholars Annual Evaluation Report: October 1, 2015-September 30. 2016

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Evaluation Summary

Preparation of adult leaders continued to be high quality, with virtually all workshop participants responding to retrospective questionnaires indicating that they felt better prepared in technical skills and content knowledge to lead groups and support youth participants in SJS activities following the training. Respondents seem to enter the workshops confident in their pedagogical knowledge, and so are less sure about the impact of the workshops on their ability to facilitate youth groups. Responding to activity completion data about active SJS adult leaders, SJS project leaders implemented structured milestones for leaders to complete in order to obtain full leader status, and receive telescope time to allocate to youth participants. Adult trainees themselves are now required to complete the requirements to become a Skynet Junior Scholar during the training. In addition, they practice Skynet website administrative functions and complete action plans. This structure has improved workshop completion rates.

SJS youth participation continued to improve during the past project year, as measured by active participation in groups, and patterns of growth in exposure requests. More groups had active middle or high school age participants than in any previous year, with 55 of 66 typical groups (>83%) having active youth participants. In addition, the average number of youth participants per group reached 9.55 and the average number of exposures requested by youth in each group grew to 305.73. In addition, the overall percentage of exposures requested by youth (compared to adults): surpassed 47% (compared to <35% in the previous project year), and the total number of exposures requested by adults actually dropped by about 13%. Notable is the finding that the average number of exposure requests in a group does not appear to be related to the size of the group. The evaluator also conducted an analysis of SJS "activity completions." Activities are organized learning sequences, designed by SJS project leadership; several activities make up one Exploration. There has been a dramatic growth in the number of youth activity completions, from 41 in PY2014, to 212 in PY2015, to 517 in the most recent project year. In addition, this project year 47% of activity completions were outside the first 2 activities in the SJS sequence, compared to 16% last year.

By categorizing the groups with an average of 9 or more exposures per youth participant (the minimum needed to "Become a Skynet Junior Scholar") by organization/institution type, it was learned that 25 4-H groups had met this standard during the SJS project, more than High School (13) and Middle School (9) combined. This is interesting, since most 4-H leaders are not content experts in science. It suggests that prior content expertise is not

required to become a successful SJS group leader, thus broadening considerably the pool of potential adult leaders.

Impact on youth. While anecdotal evidence suggests that youth participants were engaged and very active in capture, manipulation, and analysis of astronomical images, our pre and post data failed to capture this. One reason was the very high mean scores in pre surveys, suggesting that we are attracting youth who are already highly interested in STEM. The other was the relatively low response rates on post surveys, which reduced the significance of our results.

Preparation of Adult Leaders

Preparation of adult leaders continued to be high quality, with virtually all workshop participants responding to retrospective questionnaires indicating that they felt better prepared in technical skills and content knowledge to lead groups and support youth participants in SJS activities following the training. Leaders who are not technologically inclined do express reservations about the technological demands of the project on leaders. They mention tech-related glitches experienced during training, such as image response time and, occasionally, the availability of spaces with sufficient Internet bandwidth to support active SJS groups. These concerns share the characteristic of feeling out of leaders' control, and therefore undermine leaders' confidence in their capacity to provide infrastructure support to youth groups.

Respondents with little previous experience in astronomy express lack of confidence in their content area knowledge, and worry they will not be able to get the help they need from the SJS management team. This nearly always proves to be an unfounded concern, as the project design is *not* for adult leaders to *teach* the content but *to facilitate* youth in scripted and supported activities from which *they* can learn about astronomy, telescopes, optics, and astronomical inquiry. In addition, SJS staff are only too happy to assist leaders and youth when they confront difficulties, and report that they learn a great deal from those encounters. Respondents with substantial experience working with young people appear to enter the workshops confident in their pedagogical knowledge, at least as it pertains to facilitating youth in learning groups, and so are less sure about the impact of the workshops on this part of their skillset.

Responding in part to activity completion data about active SJS adult leaders, SJS project leaders implemented structured milestones for leaders to complete in order to obtain full leader status, and receive telescope time to allocate to youth participants. Among other things, adult trainees are now required—like the youth participants whose work they facilitate—to complete the requirements to become a Skynet Junior Scholar. In addition, they practice Skynet website administrative functions and complete action plans. Having trainees observe and submit materials to certify these new requirements has improved workshop completion rates, and may also be influencing activity completion rates among youth participants (see next section).

Finally, in spring of 2016 SJS developed and piloted a self-paced leader-training guide, which was updated and revised during summer 2016 based on feedback received during

the pilot. As SJS moves toward becoming self-sustaining, this lower cost method for achieving SJS leader certification is critical. A group of 13 youth leaders are engaged in the self-paced workshop right now; one adult has completed the requirements and advanced to being a leader with a youth group of his own. It is planned that this opportunity will be more widely disseminated through the 4-H networks developed during the course of the SJS project during the summer and fall of 2017.

Skynet Junior Scholars Participant Groups

The purpose of the online and face-to-face training provided to adult leaders was to prepare them with sufficient understanding of astronomy, the robotic telescope network, the web-based software tools provided to utilize it, and the SJS web portal, to recruit groups of middle school youth, introduce them to the online tools, and support them in learning about astronomy, scientific inquiry and image capture and analysis. Tables A1-A2 (below) provide a high level view of SJS groups,[1] and demonstrate the progress SJS has made across the project in recruiting and involving youth participants.

As has been discussed above, the training provided support to would-be adult leaders in mastering the technology of the robotic telescopes, in beginning to understand the software used to manipulate images, in the rudiments of astronomy and in hands on and computer based activities that might be used to introduce astronomical ideas to youth participants. What happened after the training, however, depended heavily on the initiative, capacity, and motivation of individual adult leaders.

In order to organize a group to fully participate in the SJS project, an adult leader had to identify a venue, arrange for (or figure out how to manage without) computers and an Internet connection, and then plan and launch group meetings. The latter involved recruiting, retaining, and motivating youth participants (at least, e.g., until the intrinsic motivation to explore the universe with robotic telescopes took over). Successful groups had to contend with out of school commitments such as sports activities, music lessons, and family commitments. Some leaders were free to determine the number and frequency of their group meetings independently—others (such as 4H leaders) had to work within an established time frame for conducting STEM activities in 4H clubs—often only a handful of meetings.

While leaders based at schools and museums might be able to arrange to use a room at their venue with computers in place, some leaders had to find space and equip it themselves. Groups meeting in the fall had to avoid the holidays; those meeting in the winter in northern states had to deal with frigid weather. When the Internet was balky, leaders had to make adjustments on the fly. When youth had trouble with hardware or

[1] This table and those that follow focus primarily on groups formed by an adult leader intending to recruit youth and support them as they participate in SJS. I have excluded groups formed primarily for professional development purposes, groups that are comprised mainly of adults doing research on a particular subject, groups formed to assist with project development, and certain camp groups.

software, adult leaders became their tech support professionals; at other times, adult leaders, rushed to study astronomy to stay just ahead of youth participants. Adult leaders also dealt with personal challenges—such as illness, family problems, and relocation—that prevented them from getting started quickly. And some leaders simply decided they weren't cut out to take on the challenges associated with recruiting and supporting a group.

All in all, the task of recruiting, housing, equipping, motivating and facilitating / leading an SJS youth group was complex and required determination, ingenuity, and a bit of good fortune.

Table A1 shows that in the first project year (PY2014, from project inception through September 30, 2014), 40 adults initiated groups and captured at least one image using Skynet telescopes. Adults had submitted plans to start SJS youth groups as part of their leader training, but the plans varied in widely in specificity and only half of the adult leaders of groups formed in PY2014 actually recruited student group members. 35 of the 40 groups started in PY2104, however, continued to be active in PY2015. 19 of those 35 groups had no youth participants. By the end of PY2015, however, 10 of those 19 groups had youth participants. In PY2016, there were 41 carryover groups, 19 from PY2014 and 22 from PY2015. 39 of those groups had youth participants—17 or the 19 from PY2014 and all 22 of the carryover groups from PY2015.

Table A1. SJS Groups by Project Year

SJS GROUPS…	***PY2014***	***PY2015***	***PY2016***
Initiated during Project Year	40	26	25
Initiated in PY2014 Still Active	--	35	19
Initiated in PY2015 Still Active	--	--	22
TOTAL GROUPS Active during Project Year	40	61	66
# Carryover groups with youth	--	26	39
% of Carryover groups with youth	--	74.29%	85.37%
Average # youth/ carryover group	--	9.88	8.54

Table A2 shows a similar growth pattern, documenting a steady rise in youth membership and activity from PY 2014 through PY 2016. The raw number of groups with youth members rose from 20 in PY 2014 to 55 in PY 2016, as did the percentage of groups with youth members (from 50% in PY 2014 to 83.33% in PY 2016). Additionally, the average number of youth members in each group rose steadily, as did the number of exposures requested by youth. These increases in youth participation (as well as the substantial number of carryover groups from year to year) speak to the dedication of adult leaders and their determination to recruit youth participants and to support their increasing engagement in the project. They also provide evidence that youth participants became more engaged as the project progressed.

Table A2. SJS Groups with Youth Participants

SJS GROUPS WITH YOUTH PARTICIPANTS…	***PY 2014***	***PY 2015***	***PY 2016***

Groups with youth	20	47	55
% Groups with youth	50.00%	77.05%	83.33%
Average # youth per group	7.35	8.68	9.55
Average # youth exposures requested	133.90	240.51	305.73

Skynet.com Exposures

http://Skynet.unc.edu, the website through which participants called upon robotic telescopes to capture optical images of asteroids, comets, planets, and sidereal objects, recorded data on exposures requested by project participants. While the exposure database does not tell the entire nuanced story of project activity, its data do provide a picture of the development of SJS over time that is consistent with the picture provided above. Table B1 (below), for instance, summarizes the raw numbers of exposures requested by youth and adult project participants during PY2014, PY2015, and PY2016.

It is not particularly surprising that the total raw numbers of exposures requested would rise across the project, from 10,394 in PY2014 to 37,472 in PY2015 and 40,495 in PY2016. Of particular interest, however, is the steady increase in both the quantity and percentage of total exposures requested by youth participants (from just under 30% in PY2014 to over 47% in PY2016).[2]

Table B1. Exposures by Year and Status (N=88361)

Exposures	*PY2014*	*PY2014 %*	*PY2015*	*PY2015 %*	*PY2016*	*PY2016 %*	*PY2014 – PY2016*
Youth Participants	3112	29.94%	13089	34.93%	19187	47.38%	**35388**
Adults	7282	70.06%	24383	65.07%	21308	52.62%	**52973**
TOTALS	10394	100.00%	37472	100.00%	40495	100.00%	**88361**

Tables B2-B4 use the exposure data to show more detail for groups with youth participants for PY2014, PY2015, and PY2016. Of the 20 groups in PY2014 with youth participants, 13 (highlighted in green) average more than 9 exposures per youth participant, making it possible for every youth participant to complete the 6 activities required to become a Skynet Junior Scholar; 6 of the remaining 7 (highlighted in yellow) have enough exposures that at one or more student participants could also complete the activities. Only one group (orange highlight) misses that threshold.

Table B2: PY2014 Exposures by Group for Groups with Youth Participants

Group Name	*# Youth*	*Youth Requests*	*Exposures per Youth*	*# Adults*	*Adult Requests*	*Total Exposures*
paMSgrove14	3	159	53.00	1	27	186

[2] These percentages probably oversimplify the situation. Some adult leaders requested image for their students, because of, for instance, technology obstacles or extreme limits on turnaround time. It is likely that exposure figures slightly underrepresent youth exposure capture rates.

Group Name	# Youth	Youth Requests	Exposures per Youth	# Adults	Adult Requests	Total Exposures
wi4Hpierce14	20	765	38.25	1	23	788
paMUfidisco14	13	394	30.31	1	82	476
wv4Hkanawha14	16	370	23.13	1	5	375
wi4Hwood14	7	129	18.43	0	0	129
wiHSnicolet14	5	84	16.80	1	3	87
ncOBSpari14	10	133	13.30	0	0	133
waMUpacsci14	7	92	13.14	0	0	92
wv4Hpreston14	6	78	13.00	1	2	80
ut4Hkane14	6	72	12.00	0	0	72
wv4Hbcstem14	5	55	11.00	0	0	55
wi4Hwashburn14	3	32	10.67	1	8	40
wiWCBVI14	10	101	10.10	3	54	155
wi4Hmonroe14	4	33	8.25	1	9	42
hgs	3	21	7.00	1	9	30
wi4Hspotc14	3	21	7.00	1	18	39
mdMSgms14	12	81	6.75	0	0	81
wiPLmmsd14	2	10	5.00	0	0	10
wi4Honeida14	11	45	4.09	1	5	50
ut4Hut14	1	3	3.00	0	0	3

Table B3 displays similar data for those 47 SJS groups in PY2015 that have youth participants. It adds a Status column, which indicates whether a group is a "new group" in PY2015 or "still active" from PY2014. 35 of these groups pass the 9-exposure threshold, suggesting that they could complete the activities required to complete the "Becoming a Skynet Junior Scholar" exploration. Of the remaining groups, 7 show sufficient exposures for at least one youth to complete the "Becoming" activities, while 5 do not.

In Table B4 we see similar data for PY2016. The average number of exposures per youth is about the 9-exposure threshold for 37 of the 56 groups. 16 of the 19 remaining groups show sufficient exposures for one or more youth participants to complete the "Becoming" activities, while 3 do not.

Table B3: PY2015 Exposures by Group for Groups with Youth Participants

Group Name	Status	# Youth	Youth Requests	Requests per youth	# Adults	Adult Requests	Total
mdMSgms14	sa	23	2269	98.65	1	355	2624
wi4Honeida14	sa	11	856	77.82	3	55	911
wi4Hwashburn14	sa	5	385	77.00	0	0	385
inNWsb15	ng	5	333	66.60	1	103	436
vaBGos14	sa	3	144	48.00	1	48	192
wiPLmmsd14	sa	10	413	41.30	1	4	417

Group Name	*Status*	*# Youth*	*Youth Requests*	*Requests per youth*	*# Adults*	*Adult Requests*	*Total*
mnSPelyspace14	ng	10	382	38.20	0	0	382
nc4Hhenderson14	ng	2	76	38.00	1	0	76
ut4Hut14	sa	5	186	37.20	0	0	186
wyPLcasper14	sa	22	817	37.14	1	169	986
ilCSUastro14	ng	1	36	36.00	0	0	36
wv4Hpreston14	sa	7	249	35.57	0	0	249
mdHSglenelg15	ng	6	206	34.33	1	79	285
wv4Htaylorco14	sa	22	730	33.18	1	196	926
wiOBSyofamily14	ng	15	481	32.07	5	151	632
wiHSaudubon14	ng	4	118	29.50	0	0	118
wi4Hbaraboo14	ng	7	177	25.29	1	6	183
iaDNRoccb14	sa	7	168	24.00	1	28	196
mn4Hkandistars15	ng	5	115	23.00	1	65	180
paMSgrove14	sa	4	92	23.00	1	3	95
wiWCBVI14	sa	5	107	21.40	1	2	109
wiHSnicolet14	sa	11	224	20.36	0	0	224
paMUfispace15	ng	6	117	19.50	1	5	122
waMUpacsci14	sa	6	115	19.17	0	0	115
ilPLadler14	sa	9	171	19.00	1	139	310
wi4Hspotc14	sa	56	1038	18.54	1	50	1088
wi4Helks14	ng	2	34	17.00	1	20	54
wyMSbuffalo15	ng	17	261	15.35	1	11	272
wiWSDastro15	ng	6	90	15.00	1	13	103
paMUfidisco14	sa	8	103	12.88	0	0	103
Hgs	sa	5	63	12.60	1	33	96
coHSmesa14	sa	1	12	12.00	1	7	19
scMSgable15	ng	12	144	12.00	2	31	175
wv4Hharco14	ng	11	131	11.91	0	0	131
wiMSwse14	ng	7	67	9.57	0	0	67
wiMUcreate14	sa	19	164	8.63	1	10	174
wi4Hpierce14	sa	2	17	8.50	0	0	17
flMSpbda14	ng	4	28	7.00	1	26	54
wi4Hmonroe14	sa	10	53	5.30	0	0	53
coMSlhs15	ng	6	27	4.50	0	0	27
ilHSwpcp14	ng	10	40	4.00	2	17	57
ncOBSpari14	sa	1	4	4.00	0	0	4
ilMStroyastro15	ng	14	51	3.64	1	19	70
arSPqw14	sa	2	6	3.00	1	23	29
coOBSlto14	sa	1	1	1.00	1	41	42
orSPcapelookout14	sa	2	2	1.00	1	25	27
tnMSvcso15	ng	1	1	1.00	0	0	1

In Table B4 we see similar data for PY2016. The average number of exposures per youth is about the 9-exposure threshold for 37 of the 56 groups. 16 of the 19 remaining groups show sufficient exposures for one or more youth participants to complete the "Becoming" activities, while 3 do not.

Table B4: PY2016 Exposures by Group for Groups with Youth Participants

Group Name	*Status*	*# Youth*	*Total Youth Requests*	*Requests per Youth*	*# Adults*	*Adult Requests*	*Total*
wiPLmmsd14	sa	25	4021	160.84	1	3	4024
wiOBSterns16	ng	7	1036	148.00	1	16	1052
wiWSDastro15	sa	6	725	120.83	2	90	815
coOBSlto14	sa	1	97	97.00	1	3	100
mdMSgms14	sa	13	1080	83.08	1	259	1339
mdHSglenelg15	sa	8	598	74.75	1	181	779
vaCAMPloud16	ng	14	749	53.50	1	128	877
wv4Hskywalkers15	ng	6	311	51.83	1	3	314
coMSlhs15	sa	11	526	47.82	1	4	530
il4Htcaa16	ng	11	477	43.36	1	3	480
wyMSbuffalo15	sa	22	878	39.91	1	94	972
mdACwasi14	ng	6	236	39.33	2	85	321
paHSbash16	ng	50	1843	36.86	1	26	1869
vaBGos14	sa	3	109	36.33	0	0	109
inNWsb15	sa	4	138	34.50	1	18	156
miSPchdc14	ng	23	739	32.13	1	60	799
wiWCBVI14	sa	2	51	25.50	2	13	64
wiOBSyofamily14	sa	4	96	24.00	2	71	167
paMUfispace15	sa	8	178	22.25	0	0	178
caHSsohs16	ng	12	252	21.00	1	7	259
mdHSfskac15	ng	7	120	17.14	2	14	134
ncOBSpari14	sa	1	17	17.00	0	0	17
mtHSbac15	sa	3	49	16.33	1	12	61
nc4Hhenderson14	sa	3	46	15.33	1	19	65
wi4Honeida14	sa	55	806	14.65	3	71	877
wiOBSyofamily15	ng	10	139	13.90	3	59	198
coHSmesa14	sa	1	13	13.00	1	1	13
wi4Hbaraboo14	sa	7	80	11.43	2	61	141
iaDNRoccb14	sa	1	11	11.00	0	0	11
txPLaustin14	sa	6	64	10.67	0	0	64
wiPLmadison16	ng	8	84	10.50	0	0	84
mnHStonka16	ng	6	62	10.33	1	2	64
wiHSaudubon14	sa	3	31	10.33	0	0	31
ca4Hsb16	ng	4	41	10.25	1	23	64

Group Name	Status	# Youth	Total Youth Requests	Requests per Youth	# Adults	Adult Requests	Total
il4Hscott16	ng	1	10	10.00	1	25	35
ilOBSnileswest16	ng	21	190	9.05	2	12	202
waMUpacsci14	sa	2	18	9.00	1	3	21
wv4Htaylorco14	sa	31	274	8.84	1	6	280
wv4Hroane15	ng	8	68	8.50	1	14	82
wv4Hharco14	sa	16	132	8.25	2	5	137
ilMStroyastro15	sa	19	131	6.89	1	41	172
hgs	sa	1	6	6.00	1	9	15
mdBSbaltimore15	sa	4	23	5.75	2	26	49
wyPLcasper14	sa	3	16	5.33	1	123	139
ilISVIastro16	ng	15	67	4.47	1	36	103
scMSgable15	sa	5	20	4.00	2	24	44
tnMSvcso15	sa	4	16	4.00	0	0	16
mnHSbreck16	ng	7	26	3.71	0	0	26
wi4hOCW14	sa	4	14	3.50	1	35	49
ilHSwpcp14	sa	17	54	3.18	1	14	68
wv4Hlinc15	ng	6	19	3.17	0	0	19
paMUfidisco14	sa	1	3	3.00	0	0	3
wi4Helks14	sa	1	3	3.00	0	0	3
mn4Hkandistars15	sa	4	11	2.75	1	28	39
paMSwrec16	ng	4	10	2.50	0	0	10
wiHSnicolet14	sa	1	1	1.00	1	31	32

It is notable that the average number of exposures does not appear to be related to the size of the group—both small and large groups have both high and low average youth exposure requests. This may be a consequence of the individual nature of much of the activity associated with capturing images from robotic telescopes using a web interface.

Table B5 shows groups from Tables B2-B4 that have been categorized by the institutions and organizations with which they are connected—schools, 4-H clubs, state parks, observatories, etc. For each category, the table displays the groups whose youth participants requested sufficient exposures in a given year that every participating youth could complete the "Becoming a Skynet Junior Scholar" Exploration. In the table the categories are ordered by the total number of qualifying groups across the project. It is notable that across the entire project 4-H Clubs are the leading category, ahead of high schools, middle schools, observatories, museums and planetariums, all of which might be thought to have subject matter experts more suitable to leading an astronomy group. This strongly suggests that the primary requirement for leading a successful group is not an advanced knowledge of astronomy or telescopes, and that an adult with determination, ingenuity, time, and experience working with young people can lead an SJS group.

Table B5: Categorized Groups with Sufficient Exposures For Youth to Complete "Becoming" Exploration

Group Category	*PY2014*	*PY2015*	*PY2016*	*Total*
4-H Clubs	7	11	7	25
High School	1	4	8	13
Middle School	1	5	3	9
Observatory	1	1	5	7
Museum	2	3	1	6
Planetarium	0	3	3	6
Deaf / Visually Impaired Schools / Centers	1	2	2	5
Boys Girls Club	0	1	1	2
State Park, etc.	0	2	2	4
Miscellaneous	0	1	2	3
Camp	0	0	1	1
Totals	13	33	35	81

Skynet Activity Completions

The Skynet Junior Scholars web portal invites youth and adult participants to complete Explorations (see https://skynetjuniorscholars.org/explorations). Each Exploration consists of ordered sequences of Activities. The activities in the Exploration "Become a Skynet Junior Scholar," for instance, guide the participant through exercises intended (a) to teach them to use remote telescopes, (b) to familiarize them with the http://skynet.unc.edu website, (c) to help them understand exposure time, (d) to teach them about the impact of filters on astronomical images, (e) to guide them through designing and performing a simple observing project, and (f) to assist them in adding color to telescope exposures.

Activities in other Explorations support participants in exploring the universe, photographing the night sky with an ordinary camera, and contributing to asteroid research. Participants take images, reads, watches video, and do other activities as outlined, recording his or her responses and notes in the appropriate fields on the website forms. The SJS web portal tracks data on the activities completed by each user. When finished, users indicate that they have completed the activities and SJS personnel review the notes and accept the activity as complete.

Data on completed activities can be an indicator of the effectiveness of SJS groups. More than the number of youth participants and the quantity of exposures, completed activities signify sustained effort on the part of youth and adult participants. Tables C1-C3 show us activity completions by category over the 3 project periods, PY2014 – PY2016. Each table shows us the number of youth and adult participants who have completed particular SJS activities on the SJS web portal during a particular project year. These activities are grouped together by Exploration. In PY2014 and PY2015 (Tables C1 and C2), activities from only one Exploration—"Becoming a Skynet Junior Scholar"—are represented. In

PY2016, however, a few participants completed activities from 2 other Explorations—"Asteroid Research" and "Comets to Cosmology."

Table C1: Activity Completions, PY 2014

Exploration Activity Completions	***Youth***	***Adults***	***Row Total***
Become a Skynet Junior Scholar…			
First_light	15	8	23
Scavenger	12	12	24
Exposure_time	6	9	15
Investigate_filters	3	1	4
Design_investigation / Create_it_yourself[3]	2	0	2
Make_color_image	3	1	4
Totals	**41**	**31**	**72**

Tables C1-C3 show that far more youth participants completed the First Light and Scavenger Hunt activities than any others. In PY2014, 27 of the 41 activities completed by youth (66.86% of activities completed by youth) were these 2 activities. In PY2015, 178 of 212 SJS activities completed by youth (83.97%) were the same 2 activities. In PY 2016, however, the first 2 activities constituted 304 of a total of 517 youth activities (58.80%, nearly a 30% a reduction from PY2015), meaning youth were completing subsequent activities with increasing frequency.

Table C2: Activity Completions, PY 2015

Exploration Activity Completions	***Youth***	***Adult***	***Grand Total***
Become a Skynet Junior Scholar …			
First_light	99	11	110
Scavenger	79	21	100
Exposure_time	13	12	25
Investigate_filters	9	7	16
Design_investigation / Create_it_yourself	1	2	3
Make_color_image	11	3	14
Grand Total	**212**	**56**	**268**

Table C3: Activity Completions, PY 2016

Exploration Activity Completions	***Youth***	***Adult***	***Row Total***
Asteroid_Research			
Activity_1	5	1	6

[3] The name of this activity changed over the course of the project

Exploration Activity Completions	***Youth***	***Adult***	***Row Total***
Asteroid_movie	2	1	3
Subtotals	7	2	9
Become a Skynet Junior Scholar…			
First_light	116	35	151
Scavenger	188	32	220
Exposure_time	72	36	108
Investigate_filters	58	27	85
Design_investigation / Create_it_yourself[4]	40	23	63
Make_color_image	20	8	28
Checklist	14	24	38
Subtotals	508 (73.3%)	185 (26.7%)	693 (100%)
Comets_to_Cosmology			
Astro_diagnosis	2	3	5
Subtotals	2	3	5
Leader Activities[4]			
Action_plan		17	17
Commitment_form		13	13
Community_participation		13	13
Survey		9	9
Telescope_time		10	10
Youth_account		10	10
Subtotals		72	72
Grand Total	517 (66.4%)	262 (33.6%)	779 (100%)

Table C4 summarizes data about groups with youth and adult activity completions from the project years. While the percentage of groups with adult members completing activities has remained relatively constant from PY2014-PY2016, the percentage of groups with SJS activities completed by youth has grown steadily, from 38.88% in PY2014 to 58.82% in PY2016. Additionally, as shown in Table C5, even as the total number of groups with activity completions has grown during the project, the average number of youth activity completions per group has nearly tripled.

[4] New in PY2016.

Table C4: Groups with Activity Completions

Summary Data-Groups with Activity Completions	***PY2014***	***PY2015***	***PY2016***
# Groups with Youth Activity Completions	7	23	30
% Groups with Youth Activity Completions[3]	38.88%	48.94%	58.82%
# Groups with Adult Activity Completions	13	31	35
% Groups with Adult Completions[5]	72.22%	65.96%	68.63%
# Total Groups with Activity Completions	18	47	51

Table C5: Activity Completions Summary

Summary Data-Activity Completions	***PY2014***	***PY2015***	***PY2016***
# Youth Activity Completions	41	206	517
Average # Youth Activity Completions/Group	5.86	8.96	17.23
# Adult Activity Completions	31	56	262
Average # Adult Activity Completions/Group	2.38	1.81	7.49
Total # Activity Completions	72	262	779

The evidence is strong that the Skynet Junior Scholars project has succeeded in recruiting and training adult leaders who feel able to meet the technology, pedagogy, and content knowledge requirements of recruiting and leading student groups. In large measure the projects' adult leaders have succeeded in establishing groups by recruiting and engaging youth in the work of studying the cosmos through robotic telescopes. The number of youth participants engaged in critical parts of the project, such as requesting exposures and completing the ordered activities that comprise the Explorations, the project "curriculum," has grown consistently across the project. The resources identified for the project, the Skynet telescope network and associated web interface, have accommodated youth and adult participants well, and the web portal has been consistently improved.

Further, adult and, increasingly, student participants have used the online forum associated with the web portal to communicate with one another and with project leaders and scientists. And great efforts have been made in collaboration with schools and centers for Blind/Visually Impaired and Deaf/Hard of Hearing students and adults, and are continuing, to make SJS resources available to all youth. SJS has succeeded in creating an increasingly robust community of groups of youth participants and adults who are engaged in the work of astronomy learning through use of the Skynet robotic telescope network.

Impacts on Youth Participants

We believed that participation in SJS would positively change youth attitudes toward STEM subjects and STEM professions. To test this hypothesis, we invited youth participants to complete online questionnaires at the beginning and end of their Skynet Junior Scholars experience. A number of questions related to youth participant's interest in and attitudes

[5] Note: % Groups with Youth Activity Completions and % Groups with Adult Activity Completions will not always add up to 100% because some groups have both.

toward STEM subjects, STEM learning, and STEM professions were included in both the pre- and post-questionnaires.

There were 2 different sets of pre and post surveys administered to youth participants during the project. In late April 2015 we debuted a second, briefer instrument, combining research and evaluation questions, developed in hopes of capturing post-surveys from a higher percentage of participants. This effort did not significantly increase the number of pre and post survey pairs obtained.

Adult leaders were relatively more successful in seeing that participants completed the pre-surveys, as administration was easy as part of the start-up of an SJS group. But the varied nature of youth groups, the weight of demands on adult leaders, and the limited ability of the project evaluator to systematically monitor the progress of individual youth groups spread across the country left determining and assigning the appropriate moment for and carrying out the post survey up to individual adult leaders (and youth). SJS project management encouraged and reminded adult leaders to have their youth participants complete the post questionnaires to the degree that they could, but this effort really needed substantial additional dedicated research and evaluator effort that was not in the original project design and thus not provided for in project funding.[6] Analysis of the two data sets is statistically inconclusive, for two primary reasons.

- Potential youth participants appeared to pre-sort themselves, with those opting to join SJS groups having very favorable attitudes toward and high interest in STEM professions; this resulted in high mean scores when the pre-survey was administered, and limited the amount of possible growth.[7]
- Given the relatively high mean scores from the pre-survey (and the subsequent narrowing of room for change), our failure to capture sufficient numbers of post surveys rendered us unable to achieve statistical significance.

This does not mean that youth participants were not engaged, nor is it to suggest that there was not significant learning during the project. It does suggest that we may have set out to

[6] The ultimate solution to this problem may be to move away from more formalized pre and post surveys and toward embedding evaluation questions in the online exploration activities themselves. It may prove more successful to integrate evaluation and research into the activities themselves, a question or two at a time. This approach predetermines that only the most motivated and responsive participants will respond to the evaluation questions, but that is arguably the case already. Such an approach hold real promise, provided it can be worked out to the satisfaction of Human Subjects Protection review panels.

[7] It is quite possible that some of the sorting referred to here actually occurred on the part of the recruiters, especially in schools, where those doing the recruiting might have prior knowledge of the capabilities and interests of youth, and approach those they think would "fit" or "take advantage" of the SJS program. It is also possible that some of the sorting is done by the institution, as planetariums, observatories, and museums may attract potential youth participants favorably predisposed toward STEM interests and activities.

measure the wrong thing. Youth have deepened their pre-existing interest in STEM, have extended their pre-existing knowledge of STEM, have solidified their enthusiasm about STEM, and have narrowed the focus of their interest in STEM. Likewise, some youth have found that their interest in STEM research was not as great after having the practical experience of doing research in astronomy. We do have other less systematic indicators of student enthusiasm and interest, which we shall mention briefly at the end of this section.

We will review the two sets of data regarding youth outcomes separately. The discussion of the older set relies on analyses reported previously.

Older data set. 160 youth participants completed the pre-SJS questionnaire, and 94 completed the post-SJS questionnaire, resulting in 68 valid paired responses, about 12% of 585 youth participants. As can be seen from Table Y1 below, nearly 2/3 of the paired responses came from one SJS youth group (wi4Hspotc14), and all but 1 of the remaining 23 paired responses came from 3 additional groups.

Table Y1. Youth Groups Included in Youth Questionnaire Sample

Group Name	*# Students in Sample*	*% of Sample*	*# Students in Each Group*	*% Group Completing both Pre & Post*
mdMSgms14	13	19%	29	45%
mnSPelyspace14	5	7%	10	50%
wi4Hspotc14	45	66%	62	73%
wv4Htaylorco14	4	6%	11	36%
wyPLcasper14	1	1%	16	6%
Totals	68	100%	128	53%

Not surprisingly, this sample was heavily weighted toward very active SJS youth groups. The 5 groups represented were responsible for nearly 30% of the image requests submitted to the Skynet remote telescope network during 2014 and 2015. Students in 4 out of the 5 groups were responsible for over 53% of the SJS activity completions and over 67% of the activity approvals during that same period.[8]

Youth Tables Y2 and Y3 summarize the results of the pre-and post-questionnaires by question. We used a Paired Sample t-Test to determine the significance of the differences between pre and post questionnaire response means for 34 items. Table Y2 summarizes responses to 20 questions focusing on:

- The *importance* of STEM subjects (Science, Mathematics, Technology) and comparison subjects (English / Literature and History) to the respondent's future success in life (5 questions)
- The respondent's *interest in* STEM and comparison subjects (5 questions)
- The respondent's *perception of how good they are at* STEM and comparison subjects (5 questions)

[8] The 5th group (mnSPelyspace14) is relatively recent, having been active online primarily during the 5 weeks beginning March 2, 2015.

- How much the respondent *identifies with adults who work in* the STEM and comparison subject areas (5 questions)

The most striking result of the t-Tests in Table Y2 was the absence of significant results. At a significance level of p = 0.05, only 2 items—both related to English—produced pre- to post- means changes that were statistically significant.[9] This may be partly a function of the small sample size, but may also be attributable to a relatively high pre-SJS interest in and enthusiasm for STEM embodied in this sample.

As a result, one cannot draw firm conclusions from the observations about Table Y2 that follow. The changes in means were relatively slight—only 5 items changed as much as 5%. 3 of those items were the questions related to English; 1 item was related to history. Only 1 of those 5—a technology item, whose mean increased—was about a STEM subject. While the mean response for History dropped every time it was the focus of a question, STEM subjects did not increase consistently. Science means fell off for 3 of 4 items. Technology means dropped for 2 of 4 items, and Mathematics means dropped once and stayed the same twice.

Table Y3 summarizes response means for 15 statements that reflect attitudes toward and interest in STEM learning and activity. Only 2 items produced a change in means that was significant (p=0.05):[10]

- *I like online games or computer programs that teach me about science* (+0.179).
- *I can handle most subjects well, but I cannot do a good job with science* (+0.209).

Interestingly, the mean score on both items improved even though the items might be seen as indicating attitudes that are opposed. Perhaps the fact that they imply two different contexts—alone with a computer and being a student in a classroom—or two different modes of learning—independent versus in a group—explains how the strength of agreement with both statements might increase.

None of the other means comparisons in Table Y3 were significant. As a consequence, the remaining comments about Table Y3 are qualitative. 9 of the remaining the attitude statements showed nominal positive changes in means. Means diminished from pre- to post- for the following 3 items:

- *I see myself as a science person* (-0.103).
- *My parents are proud of my science grades* (-0.147).
- *Before joining this program, I participated in science activities outside of school* (-0.104).

In addition, the negative attitude item "Science is boring" showed a negligible increase in pre to post means (0.015).

[9] These two items are highlighted in Table Y1.
[10] The change in means for both of these items was also > 5% of the original mean.

Table Y2. Paired Pre/Post Youth Questionnaire Sample T-Test Results, STEM Subjects / Professions (p = 0.05)

Pre-Post T-Test Results	***Mean Pre/Post***	***Difference in mean***	***t Stat***	***One-Tail Significance***	***Two-Tail Significance***
For each subject below, indicate how important you believe it will be to your future success in life. *Scale: 1 (Not at all important) to 5 (Very important)*					
Science	3.938 / 3.861	-0.077	-0.684	0.248	0.496
Mathematics	4.194 / 4.194	0.000	0.000	0.500	1.000
Technology	4.384 / 4.354	-0.031	-0.228	0.410	0.821
English/Literature	3.681 / 3.757	0.076	0.500	0.310	0.619
History	3.134 / 2.970	-0.164*	-1.035	0.152	0.304
How interested are you in each of the following subjects? *Scale: 1 (Not at all interested) to 4 (Very Interested)*					
Science	3.015 / 2.941	-0.074	-0.928	0.178	0.357
Mathematics	2.75 / 2.735	-0.015	-0.163	0.435	0.871
Technology	3.209 / 3.104	-0.104	-1,154	0.126	0.253
English/Literature	2.299 / 2.507	0.209*	1.778	0.040	0.080
History	3.209 / 3.014	-0.104	-1.643	0.126	0.253
How good are you at each of the following subjects? *Scale: 1 (Very bad) to 5 (Very Good)*					
Science	3.779 / 3.809	0.029	0.424	0.337	0.673
Mathematics	3.882 / 3.882	0.000	0.000	0.500	1.000
Technology	3.896 / 3.910	0.015	0.155	0.439	0.877
English/Literature	3.682 / 3.788	0.197*	2.137	0.018	0.036
History	3.603 / 3.588	-0.019	-0.123	0.451	0.902
How much do you identify or want to be like people who work in the following subject areas? *Scale: 1 (Not at all) to 5 (A great deal)*					
Science	3.059 / 2.926	-0.132	-0.903	0.185	0.370
Mathematics	2.418 / 2.493	0.075	0.510	0.305	0.612
Technology	3.242 / 3.454	0.212*	1.604	0.057	0.114
English/Literature	2.500 / 2.632	0.132*	0.778	0.220	0.439
History	2.045 / 1.925	-0.119*	-0.942	0.175	0.350

*Difference in mean ≥ .05 * original mean

Table Y3. Paired Pre/Post Youth Questionnaire Sample T-Test Results, Attitude Statements (p = 0.05)

Youth Table Y3	*Mean Pre/Post*	*Difference in mean*	*t Stat*	*One-Tail Significance*	*Two-Tail Significance*
Please indicate how much you agree or disagree with each of the following statements. *Scale: 1 (Strongly disagree) to 4 (Strongly agree)*					
I get excited to find out that I will be doing a science activity.	3.045 / 3.076	0.030	0.341	0.367	0.734
I am curious to learn more about science, computers, or technology.	3.103 / 3.118	0.015	0.145	0.443	0.885
Science is boring.	1.897 / 1.912	0.015	0.145	0.443	0.885
I like online games or computer programs that teach me about science.	2.642 / 2.821	0.179*	1.722	0.045	0.090
I understand science (for example, how computers work, how rain forms, or how airplanes fly).	3.000 / 3.090	0.090	1.000	0.160	0.321
I am sure of myself when I do science.	2.970 / 2.985	0.015	0.168	0.434	0.867
I can handle most subjects well, but I cannot do a good job with science.	1.881 / 2.090	0.209*	1.697	0.047	0.094
I know how to analyze data (for example, with charts, graphs, or calculations).	2.910 / 3.015	0.104	1.021	0.155	0.311
I see myself as a science person.	2.544 / 2.441	-0.103	-1.187	0.120	0.240
I talk about science with my friends.	2.224 / 2.254	0.030	0.314	0.377	0.754
My parents are proud of my science grades.	3.176 / 3.029	-0.147	-1.455	0.075	0.075
I help my friends with their science homework and projects.	2.478 / 2.597	0.119	1.070	0.144	0.288
I feel confident using technology to learn about science.	3.015 / 3.090	0.075	0.779	0.220	0.439
I do science-related activities that are not for schoolwork.	2.515 / 2.368	0.059	-1.425	0.079	0.159
Before joining this program, I participated in science activities outside of school.	2.388 / 2.284	-0.104	-0.817	0.208	0.417

*Difference in mean ≥ .05 * original mean

The data available from our first data set did not permit us to confirm or disconfirm our hypothesis. Unfortunately, we experienced similar results after reducing our survey to significantly reduce the time required to take it.

Newer data set.
317 youth participants completed the newer pre-questionnaire, beginning April 30, 2015, and 57 completed the post questionnaire, resulting in 31 valid paired responses a sample constituting 4% of the 774 youth participants active during that period. The very small sample size is problematic (as will be manifest in the significance scores in the Table Y5). Table Y4 details the youth groups represented in the newer data sample, and their proportions.

Table Y5 summarizes the results of the newer pre-and post-questionnaires by question. We used a Paired Sample t-Test to determine the significance of the differences between pre and post questionnaire response means for 16 items. The items focus on the respondent's

sense of confidence in his/her abilities to understand and practice aspects of science, technology, and mathematics, their resilience as learners and problem solvers, the degree to which the respondents see themselves as "science persons" or "scientists," their interest in science/technology careers and in interacting with other scientists, and their interest in learning about astronomy, science, and technology, and in doing astronomical and other science research. Respondents were presented with a 5-point scale ranging from "Strongly Disagree" (1) to "Strongly Agree" (5).

Table Y4. *Youth Groups in Newer Questionnaire Sample*

Group	***# Youth in Sample***	***% Sample***	***# Youth in Group***	***% Group Completing Both Pre and Post***
wv4Htaylorco14	9	29%	42	22%
mdMSgms14	4	13%	20	20%
ilOBSnileswest16	3	10%	21	14%
mdACwasi14	3	10%	6	50%
vaCAMPloud16	2	6%	14	14%
wiPLmadison16	2	6%	8	25%
wiPLmmsd14	2	6%	26	8%
coMSlhs15	1	3%	11	9%
mnHStonka16	1	3%	6	17%
mtHSbac15	1	3%	3	34%
wiOBSMcQs	1	3%	4	25%
wv4Hskywalkers15	1	3%	6	17%
wyPLcasper14	1	3%	12	8%
Total	31	98%[11]	96	32%

Most of the questions in Table Y5 are positive statements, meaning that they are statements we would hope to help youth respondents agree with more and more strongly. Two statements—*"I can handle most subjects well, but I cannot do a good job with science,"* and "*I have trouble analyzing data (ex: with charts, graphs, or calculations)"*—have the opposite valence. We would hope to help youth participants disagree or strengthen their disagreement with them. One statement—" *I think it would be more fun to control a telescope in person than online"*—could go either way.

The results of the paired pre and post questionnaires in Table Y5 are very close. Most of the initial means are quite high, and as a consequence, the change in means from pre to post is very small—only three items show difference in means >0.2, a very small difference. And only one item—*"I have trouble analyzing data (ex: with charts, graphs, or calculations)"*—shows a difference in means >0.3. The t-test results for that statement is the only one of the sixteen items in Table Y5 with a significance approaching 0.05, yet at 0.0574 even it does not meet the 0.05 confidence threshold. So, while all of the means in Table Y5 appear to be moving in the desired direction, we cannot argue with confidence that there is enough difference in means to draw any conclusion.

[11] Due to rounding.

Table Y5. Youth Survey Questions, Newer Data Set

Youth Survey Questions	*Pre Mean*	*Post Mean*	*Difference*	*Standard Error*	*T Statistic*	*Significance*
I am sure of myself when I do science.	3.8438	4.0000	0.1562	0.1355	1.1530	0.2577
I can handle most subjects well, but I cannot do a good job with science.	1.8438	1.6250	-0.2188	0.1538	-1.4222	0.1650
I have trouble analyzing data (ex: with charts, graphs, or calculations).	2.0625	1.7500	-0.3125	0.1584	-1.9734	0.0574
I see myself as a "science person."	3.9688	4.0000	0.0312	0.1308	0.2389	0.8127
I am curious to learn more about science and technology.	4.5312	4.5625	0.0313	0.1649	0.1895	0.8509
I feel confident using technology to do science.	3.9688	4.0625	0.0937	0.1924	0.4873	0.6295
I am interested in a career that uses science and technology.	4.0625	4.2500	0.1875	0.1764	1.0628	0.2961
I think it would be more fun to control a telescope in person than online.	3.8438	3.8125	-0.0313	0.1709	-0.1829	0.8561
Learning new technologies is important for my future success in life.	4.2812	4.3125	0.0313	0.1454	0.2149	0.8312
Using scientific instruments is important to me.	3.9062	4.0000	0.0938	0.1513	0.6195	0.5401
Interacting with professional scientists is important to me.	3.9062	4.0625	0.1563	0.1563	1.0000	0.3251
I am interested in doing astronomy research.	4.0625	3.9375	-0.1250	0.1472	-0.8491	0.4023
I want to learn more about astronomy.	4.4062	4.2500	-0.1562	0.1110	-1.4079	0.1691
When I come across a tough science problem, I work at it until I solve it.	4.0312	4.0938	0.0626	0.1551	0.4029	0.6898
Being a scientist is an important reflection of who I am.	3.5625	3.5938	0.0313	0.1308	0.2389	0.8127
I have a role model in a science career.	3.3438	3.5938	0.2500	0.1680	1.4880	0.1468

It is worth noting that there is ample anecdotal evidence of the impact of the SJS project on youth participants, much of which has been reported in previous annual reports and elsewhere in this report. This includes presentations at local, regional, and national conference by SYS youth participants, lively forum discussions, poster presentations posted on the web portal, and hundreds of photographs of heavenly objects, some rendered in breathtaking color. This evidence supports the contention that we have deepened and intensified existing interests in and aptitudes for science, astronomy, and telescopes, and related professions, rather than that we have flipped attitudes and interests.