BOY SCOUTS OF AMERICA®
PATRIOTS' PATH COUNCIL

STEM IN SCOUTING

How to STEMify Your Scouting Activities

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Abstract

STEMify[1]: The process of infusing Science, Technology, Engineering and Mathematics (STEM) activities into all Scouting programs. This College of Commissioner Science thesis discusses how STEM is everywhere in Scouting and shows leaders how they can enhance the Scouting experience through STEMification. Imagine Scouting through the lens of STEM everywhere: the geology under our feet; the stars above; the warmth of our sleeping bag; the health of proper hygiene; the thrill of learning. Our Scouting youth will learn more, have fun, be stimulated, and view their various Scouting activities through a STEM perspective. But the real benefit is that it helps our Scouting youth grow and meets the Character Development Aim of Scouting and many of the Methods of Scouting.

My thesis is that STEMifying Scouting is:

- Beneficial for all
- Completely compatible with the Aims and Methods of Scouting
- Fun.

Further, STEMifying an activity is relatively easy and can largely be done by the Scouts themselves. STEMification need not be a burden on the unit leadership; the Scouts themselves have ready access to the resources to explain the STEM of the natural environment, camping equipment, public health, cooking, communications and much more. STEMified Scouting helps with recruitment, retention, participation, and advancement. Thus, it is imperative that adult leaders at the Unit, District, Council and other levels need to facilitate STEMification. The Unit Commissioner can be a valuable vector for STEMification starting with simply spreading the word and providing encouragement. STEM-related topics can be a program feature at District Roundtables.

Readers will note a bias toward Scouting in the specifics. The principles here will be useful to Cub Leaders, Venturers, Explorers and, indeed, all Scouts and Scouters.

[1] This is a term I originated in the context of Scouting. An online keyword search indicates that other people/organizations use it in different contexts.

Introduction

The Aims and Methods of Scouting

It is important to place STEM in the overall context of Scouting. The Scouting program has three specific objectives, commonly referred to as the "Aims of Scouting." [2] They are:

1. Character development
2. Citizenship training
3. Personal fitness

The methods by which the aims are achieved are listed below in random order to emphasize the equal importance of each.

- Ideals
- Patrols
- Outdoor Programs
- Advancement
- Association with Adults
- Personal Growth
- Leadership Development
- Uniform

Each and every one of these Aims and Methods can be STEMified. **Wait!** You might say. Uniforms? Well, indeed! Your Scouting uniform consists of woven fabric that has been dyed with pigments, sewn with thread that holds up under a Scout's active wear, and designed for comfort and durability. There is chemistry in the polymers that go into the fabric, technology in the weaving, engineering in the looms,

[2] http://www.scouting.org/filestore/hispanic/pdf/521-042.pdf

and math in the calculation of size and cost. Uniforms contain fasteners (buttons, zippers, and Velcro®) that perform certain functions. The image, identity, and insignia are methods to achieve Scouting's aims and are underlain by psychology and other social sciences. Yes, there is plenty of STEM in a Scout uniform!

So it goes with the rest of Scouting. STEM is everywhere and in all aspects of Scouting. The BSA statement on STEM is in Appendix 1.

STEM in Scouting

Exploring our world and developing Scouting skills through the lens of STEM

STEM is part of an initiative that the Boy Scouts of America has taken on to encourage the natural curiosity of youth members and their sense of wonder about these fields through existing programs. From archery to welding, Scouts can't help but enjoy the wide range of STEM-related activities. To support this initiative, the BSA developed the Nova awards program so that youth members have fun and receive recognition for their efforts.

Scouting must adapt to changing times to remain relevant, attract members, and help our youth grow. STEM is a tool to meet those goals that mines the Scouts' natural curiosity, gives context to advancement requirements, and can make every activity more relevant and fun. While we will focus here on Boy Scouts in patrols and troops, STEM can reach beyond; both Venturers and Explorers can enjoy significant career exploration

opportunities through a STEM-focused program of varied activities.

Nova and Supernova Awards

Brief overview

"STEM" is the acronym for Science, Technology, Engineering and Mathematics. Across America various STEM initiatives focus on enhancing STEM education and improving our youth's competitiveness in areas that are projected to have both employment and interesting challenges that benefit the nation.

The Boy Scouts of America developed the Nova awards program to excite and expand a sense of wonder in our Scouts. By working with an adult counselor or mentor, the various program modules allow Cubs, Scouts and Venturers to explore the basic principles of STEM and discover how fun and fascinating STEM can be. The Nova award process takes place at the unit level. Each award covers one component of STEM—science, technology, engineering, or mathematics.

- Cub Scout Nova awards: Science Everywhere, Down and Dirty, Nova WILD!, Out of This World, Tech Talk, Swing!, and 1-2-3 Go! [3]
- Boy Scout Nova awards: Shoot!, Start Your Engines, Whoosh!, and Designed to Crunch[4]
- Venturer Nova awards: Launch!, Power Up, Hang On!, and Numbers Don't Lie[5]

[3] http://www.scouting.org/stem/Awards/CubScout.aspx
[4] http://www.scouting.org/stem/Awards/BoyScouts.aspx
[5] http://www.scouting.org/stem/Awards/Venturer.aspx

For those who enjoy a super challenge, the Supernova awards provide more rigorous requirements than the Nova awards. The requirements and activities strive to motivate youth and recognize more in-depth, advanced achievement in STEM-related activities.

The Nova and Supernova award requirements reference "counselors" and "mentors," respectively. The Nova awards program uses the term "STEM counselor" for the adult working with the Nova candidates. Parents and unit leaders may serve as Nova counselors even if they have little or no background in STEM[6].

A "STEM mentor," on the other hand, is ideally someone who has successfully negotiated a STEM career path or has other subject matter expertise (such as hobbies or other special training) and is willing to share accumulated wisdom and experience.

For more information about STEM and the Nova awards program, visit www.scouting.org/stem. Discover how the Nova awards program helps youth be "Prepared. For Life."

What the Nova and Supernova awards do and what they do NOT do

The Nova and Supernova awards motivate youth, teach new skills and provide advancement opportunities. The Nova award program is integrated with other advancement: it requires Cubs to earn Adventure belt loops/pins, Scouts to earn STEM merit badges, and Venturers earn STEM Explorations as part of a Nova award.

[6] Specific requirements for STEM Counselors and Mentors are here http://www.scouting.org/stem/Council/Volunteer_Support.aspx

For the Supernova awards, Scouts have to teach[7]:

> *Working with your mentor, organize and present a Nova award or other STEM-related program to a Cub Scout den or pack meeting. Be sure to receive approval from the appropriate unit leader and agree on a time and place for the presentation. If a Cub Scout den or pack is not available, your presentation may be given to another youth group, such as your troop or at your place of worship.*

The Nova and Supernova awards, however, address only selected STEM topics and are not the only way that we can infuse STEM into Scouting. We have ample opportunities to infuse STEM into all aspects of Scouting.

Infusing STEM into Scouting

As discussed above, STEM is important to our society and to Scouting. Scouts have been doing STEM-related activities since February 8, 1910, even if we called them something else at the time. The Nova and Supernova awards offer significant opportunities for Scouts, but are not the entire STEM story. We have vast, untapped opportunities to infuse STEM into our activities. This document develops a framework for STEMifying Scouting events and provides ideas, suggestions, processes and opportunities to STEMify the Scouting experience for our Scouting Youth.

[7] Nova award requirements: http://www.scouting.org/stem/Awards/BoyScouts_Supernova_Awards.aspx

My thesis is that STEMifying Scouting is:

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STEMify: Opportunities for STEM beyond the Nova and Supernova awards

STEM is everywhere all the time. Imagine Scouting through the lens of STEM everywhere. Everyday objects, actions, and phenomena can be more interesting to Scouts if they understand the underlying STEM. This is called STEMification. Regular Scouting activities are infused with STEM. There is no need to isolate "STEM time."

STEMify: The process of infusing STEM activities into all Scouting programs.

It is critical to emphasize that we are *not* turning Scouting into science class. We want to build on the STEM that our youth get in school and on their own. "STEMify" consists of challenges, games, research, observation, discussion, and only rarely a lecture.

STEMification of any Scouting activity augments the Nova and Supernova program and enhances the goals of BSA's STEM program "to encourage the natural curiosity of youth members and their sense of wonder about these fields through existing programs."[8]

- ✓ How many levers can you find?
- ✓ What metal is the blade made of? What alloy?
- ✓ What can't a knife cut? Why?
- ✓ What happens if we leave a knife out in the rain?
- ✓ Why the rough plastic sides?

[8] http://www.scouting.org/stem/AboutSTEM.aspx

Why STEMify your activities?

STEMified events address the "WHY" of Scouting activities:

- Why does my canoe turn to the port when I paddle on the starboard side?
- Why does a “thermal” blanket keep us warm?
- Why does wet wool still keep us warm, but wet cotton doesn’t?
- Why is it better to build and sleep in a quinzhee and not a tent for winter camping?
- Why does a compass needle always point toward “North”? Can any needle do this?
- Why are there different kinds of trees?
- Why 3 pots to wash dishes?
- Why is “Leave No Trace” important?

These “moments of STEM” should be fun, educational, and relevant. It should be a way to make a hike more than just pounding the miles and serve as a tool to get the Scouts to look around, be aware, and think about objects, actions, and phenomena while they are being Scouts.

STEM is a lever for Scouts to inquire and learn as they progress through their Scouting experience

STEMification also provides opportunities to answer the “Why” that leaders hear incessantly on campouts. For example, why does the *Scout Handbook*[9] specify the 3-pot method for washing dishes? The STEM answer entails the public health considerations to prevent the Scouts from getting sick. How does soap work? Why ***hot*** water? What are germs? Why does rotten food make you sick?

[9] Sc*out Handbook*, 13th Edition (2016) p. 308

How to…

This section provides practical advice on STEMification of Scouting and builds from the unit up.

How to Link STEM to Advancement

About half of Scouting is directly linked to STEM through the advancement programs. STEMifying your unit can be as simple as promoting STEM-related Cub adventures, Scout merit badges or Venturing adventures or programs. Opportunities abound. For example, a Scout could STEMify requirement #3 in the Communication merit badge "Write a five-minute speech. Present it at a meeting of a group." The Scout simply picks a STEM-related topic.

Over 40% (58/137[10]) of the merit badges are STEM related, as listed in Appendix 2. Specifically, these 58 badges are called out as options to complete one or more Nova or Supernova awards in the *Boy Scout Nova awards Guidebook*, for example:

[10] The number of merit badges changes frequently; if accuracy is needed, the reader should update this fraction.

2. Complete ONE merit badge from the following list. (Choose one that you have not already used toward another Nova award.) After completion, discuss with your counselor how the merit badge you earned uses science.

STEM constitutes 60% (39/65) of the Cub Adventures, as listed in Appendix 3.

Cyber Chip aims to keep youth safe while online. In addition to the youth protection and advancement aspects, a unit can STEMify the activity in many ways related to computing, electronics, and human behavior.

How to STEMify a Unit activity

Appendix 4 lists some museums, zoos, and other STEM-related opportunities for unit outings. Appendix 5 provides sample topics for STEMifying a troop activity. Appendix 6 presents some STEM humor and run-ons to liven up campfires.

Unit Leaders' Contribution

Adult and youth leadership can create a STEM aura about activities naturally during PLC, unit committee, and other planning meetings. Simply ask "What can we do to STEMify this event?" This can be followed by discussion on which aspects of the event to STEMify and which to just let happen. We needn't overtly STEMify every activity. Once the seed is planted, individual Scouts and patrols will develop a knack for asking "Why?" at appropriate moments and discussing the STEM of whatever is in front of them at the time.

Leaders need not be versed in the STEM topic. Those STEMifying the event will formulate the questions and find the answers.

Unit leaders can delegate a role of STEM coordinator to a passionate adult or youth. Typically, the Nova award counselor would extend that role into STEMification.

For Scouts, several of the positions of responsibility can be STEMified, including Order of the Arrow troop representative, scribe, librarian, historian, quartermaster, bugler, junior assistant Scoutmaster, instructor, webmaster, or outdoor ethics guide. For example, the bugler could present to the troop on the metallurgy of a bugle or the physics of sound.

Prepared Topics

As part of the planning for a weekend hike, the SPL reviews the route and assigns topics for the patrols to research before the hike and come prepared to present a 2-minute discussion at a rest break mid-hike, when the troop is involved with the topic of interest.

Scouts can use all the Scouting tools such as merit badge pamphlets and the EDGE[11] method as well as the tools they use in school and other activities, such as the Internet.

A weekend trek on the Appalachian Trail can be STEMified at many levels: geology, switchbacks (aka inclined planes), conservation, ecosystems, cooking, keeping warm, and more.

[11] Explain, Demonstrate, Guide, Enable http://www.scouting.org/filestore/pdf/26-242.pdf

Unprepared Topics

In some cases, it may be possible to do these on-the-fly. Say you noticed something interesting on a hike (e.g., a burl on a tree). The SPL assigns a patrol to come up with the answer and they look up the answer on a smartphone and present the results at the campfire that evening.

Smartphones[12]

The use of electronics at Scouting events has been a matter of concern and conflict for the past decade or more[13]. STEMification can turn smartphones on a campout from a distraction into a valuable tool.

Researching, presenting, and executing a STEM discussion or game can provide opportunities for fulfilling certain advancement requirements.

With the appropriate apps, smartphones have many tools for Scouting that Scouts may also use in their daily lives:

- Maps
- Compass
- Level
- Protractor
- Elevation
- Distance/height
- Pedometer
- QR code reader
- There are more; no worries, your Scouts will find them and with guidance, use them appropriately!

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[12] "Smartphone" is the common electronic device in 2017. My commentary includes any electronic devices available now and in the future that will permit one to access information or use applications. Readers in future years will have to extrapolate.
[13] On my first troop campout in 1961, our JASM packed in a battery-operated TV to watch an important football game. It was a 13" tube TV and he had to leave many "essential" camping items home to fit the TV into his pack. I was *impressed* by this big kid being so daring!

STEM Games

Many STEM topics can be made into a patrol game:

- Identify the levers in a patrol box and sort by types.
- Estimate the number of calories in a patrol dinner.
- Calculate what would be fair in a tug of war between the new Scout and senior patrols. Thread a block and tackle that makes the competition fair. Then have the tug of war, of course.
- First Class Requirement #6, "Identify or show evidence of at least 10 kinds of native plants found in your community." Make a game of it by identifying and sorting native and invasive species in the yard of your Troop meeting-place or at camp.
- Knots are not just for camping. Identify knots in "everyday life". Leaders, bring a pile of ties from your closets and teach the Scouts to tie a tie. Don't stop with the Windsor; there are many fun options for Scouts to try.
- Assemble gears to achieve a given ratio.

STEM Patrol Box

Just like many units keep a rope box, a box of first-aid teaching tools, etc., a STEM box provides tools at the ready for various STEM activities. Most of the components can be procured from home or cheaply at stores. Examples of what a STEM Patrol Box might include:

1. Tupperware box of common *household* levers (scissors, tweezers, nutcrackers, hammer, knife, nail clippers...). Sort by class; use this knowledge to identify levers around the campsite.
2. A second Tupperware box of common *camp* levers (pocket knife, tent-peg hammer, orange shovel ...). Sort by class; use this knowledge to identify levers around the campsite.
3. Screws: Wood blocks with screws partly in. Different sized screw-drivers (levers). Discuss how a screw is an inclined plane.
4. Block+ tackle+ tripod
5. Popsicle sticks
6. Hanks of rope (knots/tension/friction of knots; e.g., square v. Thief's)
7. Dry Friction (paper, sandpaper, Teflon®, graphite)
8. Liquid friction (oil, water, grease)
9. Needles + water cups to make a compass
10. A jar and lid for experiments like oil + water
11. A hand lens for up-close botany or geology
12. A glass cup, some grease, and soap for cleaning demo
13. Soap bubbles

14. Stomp rockets
15. [Keep thinking, more will occur to you!]

The box could also include various charts, instructions, conversion tables, and guides. Make sure you have the right supplies and have tested the activity/game to ensure it works.

Partnership Resources

There are many resources available to Scout units to craft a STEMy event. Appendix 4 is an example list of "Museums, Zoos, and other STEM Opportunities."

Citizen Science is a hot area, where ordinary citizens can collect invaluable data and do projects. SETI@home (Search for ExtraTerrestrial Intelligence) is a famous citizen science project. Two other examples illustrate how Scouting might contribute:

1. Eradicating Invasive species in partnership with NJ Audubon Society's Invasive Strike Team. This is a logical extension of the service work Patriots' Path Council did over the past year at Liberty State Park in preparation for the 2015 Jamboree.
2. Project BudBurst Project BudBurst participants make careful observations of the timing of leafing, flowering, and fruiting phases of plants **(***plant phenophases***)** throughout the year. Spring, summer, fall, and winter phases are all valuable. The project has two protocols, Single Reports and Regular Reports that you can follow to record your observations. Scientists and educators can use the data to learn more about how plant species respond to changes in climate locally, regionally, and nationally.

3. The Zooniverse is the world's largest and most popular platform for people-powered research. This research is made possible by volunteers—hundreds of thousands of people around the world who come together to assist professional researchers.

Of course, there are more citizen science opportunities. Scouting might contribute at the Unit, District, or Council level. Although one-time events may be both possible and productive for both BSA and the citizen science host, I envision sustained efforts as being more productive. For example, a Council could take on an invasive species eradication project and have Troops tackle specific areas in conjunction with a campout at a nearby site. Over the course of several Troops' weekend participation, the project is completed.

Citizen science also offers the opportunity to partner with other organizations, publicize Scouting, and publicize the Scouting brand. All of these are excellent ways to recruit new members and improve our standing in our communities.

How to STEMify a District or Council Event

Districts and councils host Camporees, Klondikes, Pinewood Derbies, and other multi-unit events that can be STEMified. Events like these can be STEMified similar to the unit STEMification process.

Generally, there is a built-in theme ("Pinewood Derby") or a generic event that needs a theme ("Camporee"). You may build the STEMification around the theme or vice versa:

- A Pinewood Derby can be STEMified by examining gravity, friction, inclined planes, timing and other facets of the race and relating them to the cars Scouts use and other real-life encounters.

- A District Camporee could be themed "Throwing Stuff," with events encompassing levers, pulleys, and other simple machines. For any activity/event, have brief explanations of the STEM behind it posted for the Scouts to read while waiting in line.
    - Patrol challenges could involve constructing a trebuchet or figuring out how to get a rope over a limb 10 m in the air.
    - Events could include:
        - Sling shot with paintballs aimed at a target
        - Tomahawk throwing
        - Knife throwing
        - Model rocket build, demo and launch
        - Technologies in armament systems
    - Explanations of projectiles:
        - Arrows (include fletching)
        - A baseball curve

    - Explanations of throwing devices:
        - Rifling
        - Simple vs. compound vs. cross bows
        - Ballistas vs. catapults vs. trebuchets

"STEM's not my thing, so my troop can't STEMify our outings"

I have heard variants on this theme from several sources:

- "We need to keep Scouting focused on our traditional outdoor activities
- "I majored in history. I don't like that STEM stuff"
- "None of our leaders has a STEM degree, so we can't support the program"

This thesis makes a strong case against these attitudes.

First and foremost, we owe it to our Scouting youth to give them the opportunities to experience all of Scouting's programs. Curiosity is a natural part of Scouting and of youth in general: "How can I stay dry during a rain storm?" The underlying "why, what, how" that STEM explanations provide is a critical component of making Scouting instructive. It also makes it easier for Scouts to accept certain rules. For

example, the 3-pot dishwashing requirement is best understood from a public health perspective (STEM) than an autocratic rule.

Second, we owe our Scouting youth, especially the older ones, any and all opportunities to explore careers.

Lastly, any program element that provides enthusiasm and growth is an invaluable recruiting, and retention tool. A robotics night at the troop meeting will have great attendance, right?

As leaders, we owe it to our Scouting youth to make our meetings, activities and campouts exciting, and relevant. STEMifying portions of any activity can add excitement AND education.

In my strong opinion, adult and youth leaders who are anti-STEM do Scouting a major disservice. Please embrace the opportunity for our Scouting youth AND adult leaders to learn about the STEM of the world around us.

Council Responsibilities

Appendix 7 presents Patriots' Path Council and national STEM Resources and training opportunities.

STEM Committee Vision

We will provide a robust STEM program consisting of BSA's Nova and Supernova awards, awesome activities, growth opportunities, and a view to STEM careers for Patriots' Path Council's Scouting youth.[14]

[14] PPC STEM Roadmap, dated 14 Jan 2014; incorporated into PPC Strategic Plan.

PPC's STEM Mission

PPC will provide a robust STEM program consisting of BSA's Nova and Supernova awards, engaging activities, growth opportunities, and a perspective on STEM careers for our Scouting youth. PPC's STEM program complements advancement such as Adventure loops and merit badges. STEM directly blends into many of our Summer Camp activities. STEM opens a range of exciting opportunities that can improve program, donor opportunities, youth satisfaction, and ultimately lead our Scouting youth to become better citizens in our increasingly STEM-filled world.

Commissioners

The Unit Commissioner can be a valuable vector for STEMification starting with simply spreading the word and providing encouragement. In the course of normal interactions, Unit Commissioners should inform units and stress that STEMification of activities will make them relevant, fun, and stimulating. Commissioners can also encourage unit participation in STEMy events.

Commissioner training could include STEM training so commissioners could better articulate BSA's STEM program, explain STEMification, and be able to do a few simple STEM demonstrations.

District Roundtables

"Roundtables play a significant role in providing continuous supplemental training for unit leaders. This monthly event provides program topic guidance and structure suggestions for unit leaders."[15] The core of

[15] http://www.scouting.org/scoutsource/Commissioners/roundtable.aspx

a roundtable is a program feature that can easily be STEM-related. While STEM cannot be a program feature of every Roundtable, it should be a recurring theme throughout the roundtable year. Here is a possible sequence:

1. Start with a themed discussion facilitated by a STEM Committee member and send the Units off to implement.
2. Follow a few months later with a scheduled discussion of experiences by Unit leaders (or for Scouts, presentations by SPLs would be better!)
3. Share best practices
4. Units can share hints on "STEM Patrol Boxes" to take on campouts (levers, pulleys, hand lenses and other tools to STEMify an outing).
5. Use this as a platform for STEMifying Camporees and other District events.

Conclusion

This College of Commissioner Science thesis discusses how STEM is everywhere in Scouting and shows leaders how they can enhance the Scouting experience through STEMification. Imagine Scouting through the lens of STEM everywhere: the geology under our feet; the stars above; the warmth of our sleeping bag; the health of proper hygiene; the thrill of learning. Our Scouting youth will learn more, have fun, be stimulated, and put their various Scouting activities into a STEM perspective. STEMification is NOT a duplication of what Scouts experience in school, but rather an augmentation of the Scouting activities we already engage in. STEMification need not be a burden on the unit leadership; the Scouts themselves have ready access to the resources to explain the STEM of the natural environment, camping equipment, public health, cooking, communications, and much more. STEMified Scouting helps with recruitment, retention, participation, and advancement. But the real benefit is that it helps our Scouting youth grow and meets the Character Development Aim of Scouting and many of the Methods of Scouting.

Dear Reader: You can contribute to STEMification of Scouting programs at all levels. Adult leaders can provide the framework. Our Scouting youth will figure it out! Our Scouting youth will make great STEM things happen! Everyone will benefit. It is up to you!

Appendices

Appendix 1: "What is STEM and Nova?"[16] From the BSA website.

STEM—Science, Technology, Engineering and Mathematics

STEM is part of an initiative the Boy Scouts of America has taken on to encourage the natural curiosity of youth members and their sense of wonder about these fields through existing programs. From archery to welding, Scouts can't help but enjoy the wide range of STEM-related activities. To support this initiative, the BSA developed the Nova awards program so that youth members have fun and receive recognition for their efforts.

Why STEM?

We live in a time of great opportunity. The spirit of innovation can help us overcome challenges and ensure a prosperous and secure future. To seize this opportunity, we must position ourselves at the cutting edge of scientific discovery and technological innovation.

Yet our country is falling behind in science, technology, engineering and mathematics. This is why many professionals and educators in science, technology, engineering, and mathematics believe the United States should do more to encourage students to enter STEM-related fields. These experts say our young

[16] http://www.scouting.org/stem/AboutSTEM.aspx

people need strong STEM skills to compete in the world market.[17] *We must work together to cultivate the next generation of critical thinkers and innovators.*

Ten-year employment projections by the U.S. Department of Labor show that of the 20 fastest-growing occupations projected for 2014, 15 of them require significant mathematics or science preparation.

STEM is the future

Fostering a strong STEM education is our best opportunity to boost the spirit of innovation. It's what we need to help ensure this country continues on a prosperous and secure journey. STEM literacy is also critical because it has a profound and growing impact on our day-to-day lives. Nature, space exploration, and any STEM-related interest reveal to us the beauty and power of the world we inhabit.

What Are the Nova Awards?

The Boy Scouts of America developed the Nova awards program to excite and expand a sense of wonder in our Scouts. By working with an adult counselor or mentor, the various modules allow them to explore the basic principles of STEM and discover how fun and fascinating STEM can be. The Supernova awards are offered for those who enjoy a super challenge. For more information about STEM and the Nova awards program, visit www.scouting.org/stem. Discover how the Nova awards program helps youth be "Prepared. For Life."

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[17] For example, former President Barak Obama stated "We want to make sure every single one of our students –- no matter where they're from, what income their parents bring in, regardless of their backgrounds -- we want to make sure that they've got access to hands-on science, technology, engineering, and math education that's going to set them up for success and keep our nation competitive in the 21st century." White House Science Fair 13 April 2016.

Appendix 2: Boy Scout Nova Award Merit Badge Map

Note: The list of merit badges[18] keeps changing and often new badges are STEM-related. The map here relates the badges listed in the Nova requirements books to those requirements. The list in this Appendix does NOT deny the STEM content of other badges.

[18] http://www.scouting.org/scoutsource/BoyScouts/AdvancementandAwards/MeritBadges.aspx

	Merit Badge	Nova Award (s)
1.	American Business	Designed to Crunch!
2.	Animal Science	Supernova
3.	Archaeology	Supernova
4.	Archery	Shoot! Whoosh!
5.	Architecture	Supernova
6.	Astronomy	Shoot! Supernova
7.	Athletics	Shoot!
8.	Automotive Maintenance	Start Your Engines! Supernova
9.	Aviation	Shoot! Start Your Engines! Whoosh! Supernova
10.	Bird Study	Supernova
11.	Canoeing	Start Your Engines!
12.	Chemistry	Supernova
13.	Chess	Designed to Crunch!
14.	Composite Materials	Whoosh! Supernova
15.	Computers	Designed to Crunch! Supernova
16.	Cycling	Start Your Engines!
17.	Dentistry	Supernova
18.	Drafting	Start Your Engines! Whoosh! Designed to Crunch! Supernova
19.	Electricity	Start Your Engines! Supernova
20.	Electronics	Whoosh! Supernova
21.	Energy	Start Your Engines! Supernova
22.	Engineering	Whoosh! Supernova
23.	Entrepreneurship	Designed to Crunch!
24.	Environmental Science	Supernova
25.	Farm Mechanics	Start Your Engines! Supernova
26.	Fish and Wildlife Management	Supernova
27.	Forestry	Supernova
28.	Gardening	Supernova
29.	Geocaching	Supernova
30.	Geology	Supernova

31.	Insect Study	Supernova
32.	Inventing	Whoosh! Supernova
33.	Mammal Study	Supernova
34.	Medicine	Supernova
35.	Model Design and Building	Whoosh!
36.	Motorboating	Start Your Engines!
37.	Nature	Supernova
38.	Nuclear Science	Start Your Engines! Supernova
39.	Oceanography	Supernova
40.	Orienteering	Designed to Crunch!
41.	Personal Management	Designed to Crunch!
42.	Plant Science	Supernova
43.	Pulp and Paper	Supernova
44.	Radio	Designed to Crunch! Supernova
45.	Railroading	Start Your Engines! Whoosh!
46.	Reptile and Amphibian Study	Supernova
47.	Rifle Shooting	Shoot! Whoosh!
48.	Robotics	Shoot! Whoosh! Supernova
49.	Scuba Diving	Supernova
50.	Shotgun Shooting	Shoot! Whoosh!
51.	Small - Boat Sailing	Start Your Engines!
52.	Soil and Water Conservation	Supernova
53.	Space Exploration	Shoot! Start Your Engines! Supernova
54.	Surveying	Designed to Crunch! Supernova
55.	Truck Transportation	Start Your Engines!
56.	Veterinary Medicine	Supernova
57.	Weather	Designed to Crunch! Shoot! Supernova
58.	Welding	Supernova

Appendix 3: STEM Cub Scout Adventures[19]

STEM constitutes 60% of the Cub adventures.

Adventures	Fraction	Percent
Total	39/65	60
Wolf	12/19	63
Bear	12/19	63
Webelos/AOL	15/27	56

	Adventure	Rank	Science Everywhere	Down and Dirty	Nova WILD!	Out of This World	Tech Talk	Swing!	1-2-3 Go!	Supernova Awards
1.	Adventures in Coins	Wolf	✓							
2.	Air of the Wolf	Wolf				✓				✓
3.	Call of the Wild	Wolf								✓
4.	Code of the Wolf	Wolf							✓	✓
5.	Collections and Hobbies	Wolf	✓	✓		✓				
6.	Digging in the Past	Wolf	✓	✓	✓					
7.	Finding Your Way	Wolf					✓			
8.	Germs Alive!	Wolf	✓			✓				
9.	Grow Something	Wolf	✓	✓	✓					
10.	Motor Away	Wolf				✓	✓	✓		

[19] http://www.scouting.org/Home/CubScouts/Parents/Awards/CubScoutAcademicsandSportsProgram.aspx

	Adventure	Rank	Science Everywhere	Down and Dirty	Nova WILD!	Out of This World	Tech Talk	Swing!	1-2-3 Go!	Supernova Awards
11.	Paws of Skill	Wolf						✓		
12.	Spirit of the Water	Wolf			✓					
13.	A Bear Goes Fishing	Bear	✓		✓			✓		
14.	A Bear Picnic Basket	Bear			✓					
15.	A World of Sound	Bear					✓			
16.	Baloo the Builder	Bear						✓		
17.	Bear Picnic	Bear	✓							
18.	Critter Care	Bear	✓	✓	✓					
19.	Forensics	Bear								✓
20.	Make It Move	Bear					✓			✓
21.	Marble Madness	Bear								✓
22.	Robotics	Bear			✓				✓	
23.	Super Science	Bear		✓						✓
24.	Super Science	Bear			✓					
25.	Adventures in Science	Webelos[20]		✓		✓		✓		
26.	Build It	Webelos					✓			✓
27.	Building a Better World	Webelos								✓
28.	Camper	Webelos	✓							
29.	Castaway	Webelos								✓
30.	Earth Rocks!	Webelos	✓	✓						
31.	Engineering	Webelos				✓		✓		
32.	First Responder	Webelos								✓
33.	Fix It	Webelos					✓			
34.	Game Design	Webelos				✓			✓	
35.	Into the Wild	Webelos			✓					✓
36.	Into the Woods	Webelos			✓					✓
37.	Maestro!	Webelos	✓							
38.	Movie Making	Webelos					✓			
39.	Sportsman	Webelos						✓		

[20] Webelos/Arrow of Light

Sources:
http://www.scouting.org/Home/CubScouts/Parents/Awards/CubScoutAcademicsandSportsProgram.aspx
http://www.scouting.org/stem/Awards/CubScout.aspx
http://www.scouting.org/stem/Awards/Webelos.aspx

Appendix 4. Museums, Zoos, and other STEM Opportunities

New Jersey is packed with places that can offer your Troop or Crew a great SETM opportunity. Here is a list we have developed for the Patriots' Path Council area of NJ. Readers from other councils/areas can assemble similar lists. There are more at the State's site on Museums: Amusement & Water Parks, Aquariums, and Historic Sites & Memorials.

Venue	Scout Merit Badges[21]	Scout Nova
Bell Labs Museum/Murray Hill (Free! Awesome!)	Inventing, Electronics	
Franklin Mineral Museum	Geology	Supernova
Frelinghuysen Arboretum	Forestry	
Morristown National Historical Park ("Jockey Hollow")	American Heritage	
Museum of Early Trades & Crafts	Inventing	Whoosh! Supernova
NJ Audubon	Bird Study; Reptile Amphibian Mammals	
NJ Makerspace /RU/NJIT		
Planetarium at Raritan Valley Community College	Astronomy	Shoot! Supernova
Society of Model Engineers (Carlstadt)		
Sterling Hill Mining Museum	Geology	Supernova
The Great Swamp		
The Longo Planetarium at County College of Morris	Astronomy	Shoot! Supernova
TransOptions		
Turtle Back Zoo		
Whippany Railway Museum	Railroading	Start Your Engines! Whoosh!

[21] The MBs and Nova's listed are my assessment of potential alignments for illustration. The venue may/may have any programs or other involvement with Scouting.

Appendix 5: Sample Topics to STEMify an activity

STEM is everywhere all the time. Everyday objects, actions, and phenomena can be more interesting to Scouts. Examples:

1. Camp
    a. What is the STEM of archery?
    b. What is the STEM of sailing?
    c. Bring a microscope and look at pond water, snowflakes, and other phenomena.
    d. Identify the simple machines in camp.
2. Chemistry
    a. What is fire? (compare to rusting, digestion, and explosions as chemical reaction kinetics)
    b. Water purification
    c. Egg protein denaturation
    d. Pigments and dyes
3. Physics
    a. Bubbles and films
    b. Block and tackle for bear bag
        i. Mechanical advantage
    c. Explain and demonstrate that bicycle wheels are gyroscopes.
    d. Why is the sky blue?
    e. How do I float in water?
    f. How do coats and sleeping bags keep you warm? (Insulation—thermos and sleeping bag)
    g. Heat transfer
        i. Al—excellent
        ii. Cotton—so-so
        iii. Vacuum—excellent (zero)
        iv. Trapped air—good
            1. How can a quinzhee possibly keep me warm?
        v. How does a thermos know to keep hot stuff hot and cold stuff cold?
    h. PV= nRT examples
    i. Gravity and keeping your tent dry
        i. Ground cloths
        ii. Pitch your tent with head up or across the slope? (Scouting Mag Nov-Dec 2016, p. 34)
4. Biology
    a. Trees
        i. What is the chemistry of wood (cellulose and lignin)
        ii. How does the tree turn CO2 into sugars and then into cellulose and lignin?
        iii. The mix of tree species in a forest—what is native, what is invasive, what stage of forest succession is it?

iv. Why are leaves green?
v. Why do they turn red (etc.) in fall?
vi. Name 3 symbiotic relationships trees have
vii. How does sap get to the top of a tree?
viii. Anatomy from root tips …leaves
ix. How tall is that tree?
x. Which species would you use to make:
1. An acoustic guitar
2. Baseball bat
3. Paper
4. 2X4
xi. Pests killing our forests

b. What are all those critters under a rotting log?
c. Why are bees important?
d. Why are bears a nuisance at camp and on the trail

5. Engineering
a. Your tent
i. Water resistant fabric—breathe, yet waterproof
ii. Air gap between tent and fly
iii. Tension
iv. Gore-Tex®—PTFE
b. What makes a raincoat repel water?
c. Why are the boards in the ceiling of the cabin arranged the way they are?
d. How is the dam at camp constructed?
e. Why is a log Ok for a short bridge, but not for a long bridge?
f. Switchbacks on a trail (inclined plane)

6. Geology
a. Why are magnetic and true North different (declination)?
b. The geology under our feet on a trail
c. Tooth of Time
i. How did this rock get to 2744 m above sea level?
ii. Why is it standing out above everything else?
iii. How old is it?
iv. How did the rock form?
v. What is that greenish stuff on some rock surfaces?

7. Health
a. Why wash your hands after urination or defecation?
b. How does antibiotic cream work?
c. Water purification—how and why?
d. Why do we use soap to wash dishes? (How do soap molecules work?)

8. Nutrition
a. My Plate
b. Why does the egg turn from clear to white when I cook it?

   c. Is our patrol dinner balanced; if not how could it be improved?
   d. Why can't I drink salt water?
9. Env. Sci.
   a. Water cycle
      i. Where does the water at camp come from?
      ii. Where does it go?
      iii. Floods
      iv. Droughts
   b. Pollination (great for spring/early summer)
   c. Critters in camp
      i. Get hand lenses for Scouts to observe in leaf litter, rotting logs and elsewhere
      ii. Turn a shovel of earth. Examine.
10. Sustainability
   a. What practices could be improved at this camp?
   b. How can we reduce waste on a campout?
11. Meteorology
   a. What is lightning and thunder?
   b. Why is the sky blue?
12. "Everything"
   a. The STEM of the car the patrol is riding in (gasoline, engine, transmission, pneumatic tires, etc.)
   b. What is fire?
   c. The STEM of your backpack

Appendix 6: STEM Humor: Run-ons and Jokes

Run-ons are time-tested campfire hits. 1-2 Scouts run through the campfire scene, deliver a short joke and run off the scene. Other humor can be used in a variety of situations. Here are a few STEM-related humor items.

S Science

- A photon is going through airport security. The TSA agent asks if he has any luggage. The photon says, "No, I'm traveling light."
- What did one DNA say to the other DNA?
    - "Do these genes make me look fat?"
- The bartender says, "We don't serve time travelers in here."
    - A time traveler walks into a bar.
- A Higgs Boson comes into a Catholic church.
    - The priest says "We don't allow Higgs Bosons here."
    - The Boson replies "Without me, there is no mass."
- Two Atoms meet.
    - Atom 1: "I've lost an electron."
    - Atom 2: "Are you sure?"
    - Atom 1: "I'm positive."
- Two Stevens students were taking organic chemistry. Going into the finals, they had solid A's. The weekend before the final they traveled to an Alpha Phi Omega weekend conclave at Princeton.

Their chemistry final was on Monday and they planned to get up early and drive back to Hoboken. They both overslept. Arriving at Stevens after the final, they found their Professor after the final and explained they had missed the exam because they'd been at an APO conclave and had planned to come back in time to take the final. But they'd had a flat tire on the way back, didn't have a spare, and couldn't get help for a long time. So they were too late getting back to write the exam. Sympathetic to the situation, the professor allowed them to make up the exam. After being seated in different rooms the two opened their exam books and began working.

- Q1: (5 points): Draw the structure of benzene.
- Q2 (95 points): Which tire was flat?

T Technology

- Give a person a fish and you feed them for a day; teach them to use the Internet and they won't bother you for weeks.
- ANY KEY will initiate hard drive format. Continue? Y or N?
- If I had asked people what they wanted, they would have said faster horses.

HENRY FORD

- Be nice to nerds. Chances are you'll end up working for one.

BILL GATES

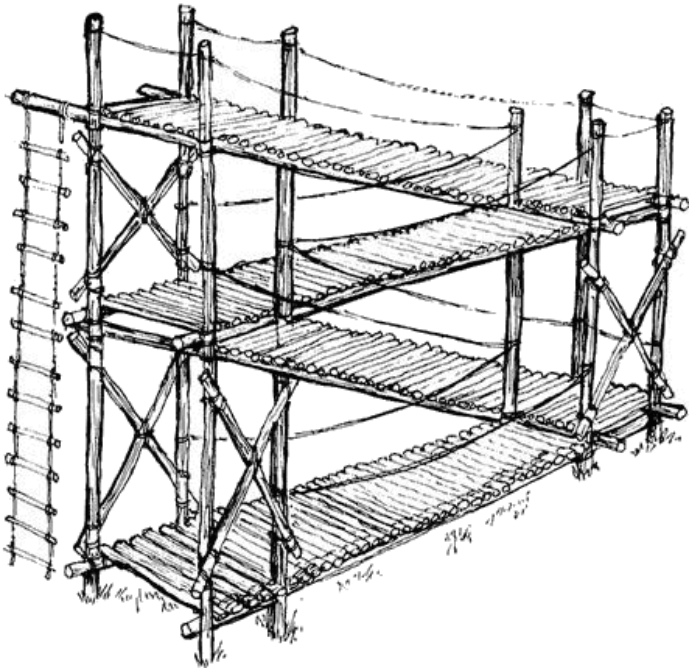
- An electrical engineer, mechanical engineer and software engineer are on their way to a trade show when their car stalls and they are forced to pull over to the side of the road.
    - The mechanical engineer says, "It's probably a mechanical problem. I'll get my tool box out of the trunk and I can fix it."
    - The electrical engineer says, "No, I'll bet it's an electrical problem. I have my multimeter with me and I'll go check it out."
    - Finally, the software engineer says, "I have the solution!" Let's close all the windows, then open them back up again. I'll bet we'll be back on the road in no time."
- Nail: An aiming device for the hammer to hit the thumb.

It's called 'reading'. It's how people install new software into their brains.

E Engineering

- Normal people believe that if it ain't broke, don't fix it. Engineers believe that if it ain't broke, it doesn't have enough features yet.
- What is the difference between Mechanical Engineers and Civil Engineers?
    - Mechanical Engineers build weapons, Civil Engineers build targets.
- Philosophy:
    - The optimist says, “The glass is half full”.
    - The pessimist says, “The glass is half empty”.
    - The engineer says, “The glass is twice as big as it needs to be”.
    - And the scientist says the glass is full: 50% liquid water and 50% gaseous air
- When I was a kid my dad used to tell me that I was going to be an Astronaut when I grew up, because all I did in school was take up space.
- A group of NASA mechanical engineers were brainstorming how they might overcome the thermal challenges involved in sending a manned probe to the sun. An electrical engineer overheard their discussion and suggested "Why don't you just go at night?"
- A priest, a tax collector and an engineer get caught up in a revolution and all are sentenced to die by guillotine.
    - The priest is the first to be clamped into the dilapidated old slicer. The rope was pulled but the blade refused to fall. All proclaimed it a miracle and decided it was divine intervention and the priest was released.

- The tax collector was next and all knew that this hated man would surely die. The rope was pulled the blade dropped and stopped halfway. All agreed that there must be something redeeming about this man that would bring about such mercy and they released him.
- The engineer was then led to the place of execution and they prepare to lock him in. He glances up at the blade and says "Hey, I see your problem!"



http://im-possible.info/english/art/escher-inspired/clarke-green.html

M Math

- The roundest knight at the Round Table was Sir Cumference. He had too much pi.

Q: Why is 6 afraid of 7???

A: Because 7 8 9!

Q: What did 0 say to 8?

A: Nice Belt!

Q: how many times can you subtract 7 from 83, and what is left afterwards?

A: I can subtract it as many times as I want, and it leaves 76 every time.

- Life is complex. It has real and imaginary components.
- The problem with math puns is that calculus jokes are all derivative, trigonometry jokes are too graphic, algebra jokes are usually formulaic, and arithmetic jokes are pretty basic.
- I put my root beer in a square glass. Now it's just beer.

Q: Why should the number 288 never be mentioned?

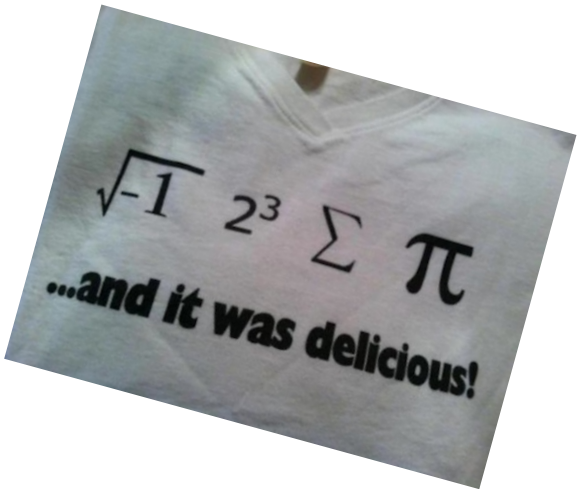
A: Its two gross.

Q: How do mathematicians scold their children?

A: "If I've told you n times, I've told you n+1 times …"

Q: Did you hear about the mathematician who's afraid of negative numbers?

A: He will stop at nothing to avoid them.



- Counting in binary is as easy as 01 10 11
- There are 10 kinds of people in the world: Those who know binary and those who don't.

Humor Resources

http://jokes4us.com/miscellaneousjokes/foodjokes/potatojokes.html

http://joecasaletto.com/jokes/quadriplegic.htm

Appendix 7: STEM Resources and training

Knowledgeable experts such as a camp counselor, STEM teacher, or a professional can be consulted. Resources on-line, in libraries and elsewhere are invaluable. Many experiments and demonstrations are aimed at STEM teachers; search by topic and grade level.

Patriots Path Council's STEM committee provides valuable resources:

- Presentations on
  - Implementing STEM/Nova in your Pack
  - Implementing STEM/Nova in your Troop
  - Implementing STEM/Nova in your Crew
  - Supernova Award Class Presentation
  - "Infusing STEM into Troop Events 301" has been presented at Patriots' Path Council University of Scouting, most recently 3 Dec 2016.
- A library of InstaSTEM write-ups that can be used by Scouts.

BSA National resources

BSA's resources include merit badge and Nova award pamphlets available online or at your local Scout shop.

Several slide presentations and three national in-person STEM training opportunities are presented below. Note the strong emphasis on infusion of STEM into the traditional Scouting activities and leaning the "why and how" behind the Scouting activities we have always done.

STEM Orientation

These courses are intended to be used to provide an orientation for Scouts, Scouters, and parents about Scouting and the STEM program and the STEM opportunities in Scouting. The instructor-led course is designed to be used with the STEM Orientation slide deck at roundtables and other training events.

STEM Orientation Self-Study slide deck

STEM Orientation Instructor's guide

STEM Orientation slide deck

STEM Nova Counselor Training

These courses are intended to provide training for STEM Nova counselors. The instructor-led course is designed to be used with the training slide deck at group courses.

Counselor Training slide deck

Counselor Training Instructor's Guide

Counselor Self-Study slide deck

Counselor Self-Study Guide

STEM Supernova Mentor Training

This course is a self-study training course for STEM Supernova mentors.

BOY SCOUTS OF AMERICA
PATRIOTS' PATH COUNCIL

Mentor's Guide

STEM Treks - Philmont Scout Ranch

For the third year, the STEM Trek will offer each participant the chance to explore the Philmont backcountry in a whole new way! Investigate the why and how behind backcountry programs like rifle shooting, blacksmithing and rock climbing. Led by knowledgeable staff, participants will explore modern scientific principles in physics and biology as well as historical examples of technology employed by miners, loggers and homesteaders during the 19th century.

Topics discussed include chemistry, material science, geology and astronomy, with hands-on activities using forestry tools and examining water quality. The experience of working on such a wide array of projects will provide vital knowledge for use at local council camps and managed areas in the participant's community when he or she returns home.

Note that the Philmont STEM Treks emphasize STEMification of Philmont. This is not an advancement program: "Nova" is not mentioned on the website.

STEM-Tastic Scouting - Inspiration, Imagination and Innovation (Philmont)

This week-long STEM (Science, Technology, Engineering, and Math) conference is designed to help you and your council integrate STEM programs and activities into your current programming. There will be many opportunities to experience hands-on activities to share with your units; these activities will be accompanied by discussion on how to implement, modify, and incorporated them in and for your

programs. Excitement, roadblocks, funding, recruitment, training, resources, and tracking will be topics addressed by this conference.

The Philmont STEM-Tastic[22] Training Conference emphasizes STEMification of council programs. "Nova" is not mentioned in the syllabus.

Other Opportunities

In 2016, BSA offered a week-long STEM conference at Florida Sea Base, Philmont Training Center, and Summit Bechtel Reserve. "There will be many opportunities to experience hands-on activities with discussion on how to implement, modify, and incorporate them into your programs." As of 28 December 2016, I could find no comparable 2017 courses. Searching within www.scouting.org or an external search engine (e.g., Google) may provide options for additional BSA training opportunities.

[22] I consider "STEM-Tastic" and "STEMify" as synonymous.