Steps to starting a 4-H LEGO robotics program
(Adapted from Cornell 4-H Robotics Program & National 4-H Robotics Modules)

Congratulations on your decision to start a robotics program! All of these steps are relevant parents and club leaders. Club Leaders will also need to decide on the educational specific outcomes that they are trying to achieve as well as how robotics aligns with their school district's standards.

Step by step organizer:

1. Decide what it is that you want to teach and how robotics will be an effective organizer. e.g. are you using robots to reinforce and teach math concepts, programming, teamwork, problem solving, or are you preparing your students for competitions?

2. Select the hardware that you will use as well as the programming language that will be appropriate with the students that you teach.

3^{rd}-8^{th} grade – Robotics is the ideal organizer to reinforce fundamental mathematics and scientific process, it also allows the teacher to introduce the concepts of systems integration, digital control, and innovative design.

LEGO NXT is an ideal solution for teaching; The LEGO Mindstorms Education Base Set or EV3 Education Base set will allow youth to learn self guided step in being able to build and program the basics in LEGO NXT Programming. If it is in your budget, we recommend purchasing at least one Education Resource Set with every two NXT Education Base Sets. This accessory kit includes many parts and connectors not included in the Education Base Set; including tracks. The curriculum is also purchased separate.

NXT-G is the original programming language for the LEGO NXT robots and is appropriate for this age group. Many curricula are out there that are developed based on this language such as the Carnegie Melon Curricula that will help with assistance if you want to purchase these.

High School – LEGO NXT or VEX is an excellent choice at the high school level. The NXT offers teachers an inexpensive tool to teach embedded systems, advanced programming, and engineering competencies. High school teachers have the option to include accessory kits and a whole array of third party sensors such as the compass sensor, accelerometer, tilt or gyro sensor, color sensor, and cameras. Appropriate programming language options for the high school students include the NXT-G programming language, ROBOTC, LabVIEW and Java. The high school teacher may want to augment their course by using one or more of the competition models that can be found for free at this site, or enter their school into a robotics competition. There are many other platforms that a high school teacher may want to evaluate, but the LEGO NXT brick is a very powerful platform to use to introduce robotics.

The VEX Robotics Design System offers students an exciting platform for learning about areas rich with career opportunities spanning science, technology, engineering and math (STEM). These are just a few of the many fields students can explore by creating with VEX Robotics technology. Beyond science and engineering principles, a VEX Robotics project encourages teamwork, leadership and problem solving among groups. It also allows educators to easily customize projects to meet the level of students' abilities. The VEX platform is expanding rapidly and is now found in middle schools, high schools and university labs around the globe. Robotics hobbyists also appreciate the advanced capabilities of the VEX System.

3. Decide on the size and number of student teams.

a. All work can be done in teams of 1 to 4. Teamwork is a crucial skill in the modern workplace, and the challenges of the robotics activities lend themselves to group solutions.
b. Odd numbers of students on a team can often lead to problems with one student being left out and not doing anything. Groups larger than 4 are generally too large for all the students to have something important to do.
c. For classrooms, two students per robot is ideal; for clubs and teams, many leaders need to have a higher student to robot ratio based on resources. Feel free to adapt to your group with alternative activities and groups to make it work.

d. First-time leaders typically do well with about 8 students. If possible, recruit other mentors to lead the subgroups within your team. These can be specialist or other club leaders that help engage the kids in different areas of engineering or computer or science.
f. Define roles on the team and have students change roles on a regular basis, allowing them to share responsibility for all aspects of building, programming, etc.
(1) Engineer (Builder)
(2) Software Specialist (Programmer)
(3) Information Specialist (Gets the necessary information for the team to move forward)
(4) Project Manager (Whip-cracker)

4. Identify technical and logistical requirements

a. Robots – Robotics Academy recommends one robot for each team of 2 students. Also, the teacher should have several backup robots in case of emergency situations. Even though this is optimal this can be changed to fit your situation with robotics while using Junk Drawer Robotics as an alternative as well or using group sharing of robots (every group has a computer, but then robots are put on central table and gotten when time to program and test a computer task/program)
b. Computers -Ideally, there should be one computer for each robot / team of students. Most of the students' activity will be independent and self-directed as they iteratively program / test / debug their solutions multiple times during each practice. Multiple computers will provide easy access to the programming language, eliminate "traffic jams" and inadvertently changing another team's program.
c. Classroom / Practice area
(1) Room size and setup – The space should be large enough to accommodate all the student teams, computers, practice tables, projector for lessons, and storage area for the robots.
(2) Practice table – Required to avoid damage to robots and keep activities accessible to all students. At a minimum, the table should have borders to prevent robots from falling off. The FIRST LEGO League challenge table specifications will accommodate a 4x8 foot surface. A flat surface with adults paying attention to the boards also works. I do suggest purchasing a generic mat at some point which will help with doing general challenges once youth have went through the entire lego educator. General mats cost $40 and can be reused.
(3) Parts storage – To keep parts organized and accessible for teams, parts organizers are necessary. There are many options – portable organizers, drawer cabinets, boxes, caddies, etc. These are readily available online and at local hardware and crafts stores. Lego Education Kits come with part organizers. A box with numbers is also useful to put built robots.
d. Network - The software and curriculum will need to be loaded on each computer or available via the network on each computer. Programs should be included in the regular system backup or leader should make a backup to a separate disk or memory stick.
e. Projector – Teachers will find it valuable to review videos, building instructions, etc. with the entire class. This depends on your level of hands on. I have not used a projector, I go kid to kid to see where they are and what they are getting stuck on.

5. Prepare a budget and get funding

a. Typical classroom budget – will consist of robots, programming language, curriculum, materials, competition fees, etc. The final cost for your robotics program will depend on the size of your team, activities, etc. Here are typical costs to use when calculating your budget:
(1) Robots - Robotics Academy recommends one robot for every two students.
    $295 for each LEGO MINDSTORMS Education Base Set
    LEGO EV3 Education Kit- $340
    $100 for each Education Resource Set Mindstorm; one for every two robots (optional)
    $100 for each Education Resource Set for EV 3
(2) Programming Software
    (a) Lego Mindstorm Education Software-$80
    (b) Lego EV3 Education Software-$100

(3) Storage bins/cabinets
This is a must have for any teacher implementing a LEGO robotics program. Your budget will be dependent upon the selection of the cabinet and bin combination that you choose. The proper storage compartments as well as classroom procedures will make teaching robotics much easier. This will vary depending on what you choose. You can get creative and might have something that already works.
(4) Practice Table ($100) and competition mat ($40.00)
(5) Optional Expense- Robotics Curriculum- Homeschool Robotics Engineering I: Introduction to Mobile Robotics Curriculum ($60) other curriculum available from variety of sources.

b. Potential sources of funding – Be sure to acknowledge your sponsors at every opportunity, e.g. print their names on your team shirts, etc.
(1) School district
(2) Local businesses
(3) Local non-profit organizations
(4) Individual donors with an interest in science education
(5) Local foundation grants
(6) National robotics grants and funding

7. Connect with the robotics educators in the community locally and virtually
a) Find another robotics team in your area and ask to attend their practice sessions.
This is very helpful for first-time leaders.
b) Attend a competition or mock competition at a fair or the State Fair
c) Attend training or educational workshops

Recap of the major steps to implement a robotics program:
1. Purchase robot kits
2. Load software and curriculum on your computer and school network
3. Build practice table (optional)
4. Practice building and programming your robot
5. Recruit older students as mentors/assistants
6. Prepare lesson plans or a plan of work

Resources:
Cornell 4-H Robotics Resource Page: http://nys4h.cce.cornell.edu/about%20us/Pages/4-HRobotics.aspx
National 4-H Robotics Resource Page: http://www.4-h.org/resource-library/curriculum/4-h-robotics/facilitator-resources/professional-development/