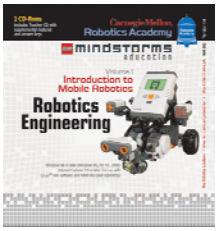
Running a Robotics Classroom Checklist

- Logistics/Installation
  - ☐ Acquired/reserved computers – one per group of 2-4 students
  - ☐ Installed *LEGO® MINDSTORMS® Education NXT Software* on each computer
  - ☐ Installed *Robotics Engineering Vol. 1: Introduction to Mobile Robotics* CD on each computer (or on shared server and add shortcuts to student computers)
  - ☐ Purchased chargers for included NXT rechargeable batteries, or purchased 6x AA batteries for each NXT (plus spares!)
- Pre-Lesson
  - ☐ Assigned students to teams of 2-4
  - ☐ Determined whether students will be using Taskbot or the REM model for activities
  - ☐ Determined whether students will be using Motor or Move blocks as their initial programming method
  - ☐ Established rules regarding the modification of robots and other resources that are shared among multiple groups/class periods
  - ☐ Have robots built by student volunteers (recommended)
- Teacher Preparation
  - ☐ Scope and sequence of Robotics activities chosen
  - ☐ Read through Teacher Notes for each lesson in the sequence
  - ☐ Step through the student steps for each activity if possible, or even do the activity yourself if you have time
- Lesson
  - ☐ Introduce lesson, optionally using the supplied Lesson Starter PPT presentation
  - ☐ Direct students to the appropriate starting point at the beginning of the lesson, and let them begin.
- End of Class (each period)
  - ☐ Return the robot to the original state (remove attachments; undo any changes you made to the gears, wheels, etc.)
  - ☐ Clean up loose LEGO parts (use the sorting trays and maps)
  - ☐ SAVE ALL PROGRAMS
  - ☐ Assign homework questions
- End of Lesson
  - ☐ Collect worksheets to correct
  - ☐ Hold final discussion to answer any student questions
  - ☐ Administer Quiz
  - ☐ Move on to next lesson
- End of Project
  - ☐ Select one or more End of Project Activities
  - ☐ Schedule milestone dates – outlines, drafts, final presentation/competition, etc. depending on the specific activity chosen
  - ☐ Assign the selected activity at least 2-3 weeks before it is due
  - ☐ Prepare classroom or venue for final presentation or competition if applicable
  - ☐ Hold final presentation/competition

Running a Robotics Classroom Notes

- Logistics – Computers
  - Each group will need access to a minimum of one computer for best results. This computer must meet the minimum system requirements for both the NXT Programming Software (see Programming Software packaging for details) and the Robotics Engineering activity software.
  - If additional machines are available, you may consider two computers per team. This will allow the group to run the NXT Programming Software on one computer, and view the lesson instructions on the other; they can be used together on the same computer, but this separation makes it easier to see both at the same time.
- Logistics – Software and Installation
  - There are two separate pieces of software that need to be installed: the *LEGO® MINDSTORMS® Edu NXT Software*, and this Robotics Engineering activity pack.
  - The *LEGO® MINDSTORMS® Edu NXT Software* ("NXT Software") is the program which allows students to write block-based programs to control their robots. The Programming Software should be installed separately on each computer.
  - The *Robotics Engineering Vol. 1: Introduction to Mobile Robotics* activity pack ("Robotics Engineering activity pack") is the software which contains the lessons designed to work with the NXT Base Set #9797.



This program comes as a 2-CD set:

- One main CD with the student material.
  This CD should have its contents installed on every computer. Alternately, it can be installed once on a network server, and each student workstation can be configured to run the program off the server by opening a shortcut/alias to the main program file.

- One Teacher CD
  This guide "Running a Robotics Classroom" is from the Teacher CD. The Teacher CD is not meant to be installed on any computers; instead, it is designed to run directly from the CD so that access to the answer keys requires physical access to the Teacher CD.

- Batteries and Power Management
  - The 9797 Base Set includes one rechargeable Lithium-Ion ("Li-Ion") battery per set; however, its use is optional, and a charger is not included by default.
    - You may elect not to use the rechargeable battery, and use six AA batteries per NXT instead. These will need to be replaced (or recharged, if you are using rechargeable AA cells) periodically as they are used up.
    - You may purchase chargers for the Li-Ion NXT battery from your LEGO Education distributor, or you may already have a compatible AC adapter/charger from a previous LEGO product (e.g. the RCX power adapter). Check the voltage specifications for the adapter before attempting to use it with the NXT rechargeable battery!

  - Use of the rechargeable battery is recommended for several reasons:
    - The NXT Li-Ion battery can typically be used (under normal conditions) for an entire school day without recharging. Lower-capacity AA batteries may not last as long.
    - The Li-Ion battery will generally provide the same amount of power to the NXT motors the whole time until they run out of power. Alkaline AA batteries will provide more power when they are fresh, and provide less and less power as they run down – this will contribute to inconsistent robot movement over the course of the battery's life. For many robot navigation activities, consistent movement is crucial, and the variability of alkaline battery power can prove a frustrating obstacle.
  - If you get one charger for each battery, you can simply plug them all in to charge overnight
    - The batteries will monitor their own power levels and prevent overcharging.
    - This may require the use of power strips to get enough plugs for all the chargers, depending on the layout of your room and the number of robots you have.
    - Check with your facility's management to make sure that your room is able to handle the electrical current from a number of batteries charging simultaneously.
- Student Teams
  - All the Robotics Engineering activities are designed to be done by students working in teams. Teamwork is a crucial skill in the modern workplace, and the challenges of the Robotics activities lend themselves to group solutions.
  - Quizzes and exercise portions of worksheets are exceptions to this rule. They are designed to be done by individual students for assessment purposes.
  - Students should be formed into teams of 2 or 4 in most cases. 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.
  - Unisex teams may be preferable, depending on the age range of the students.
- Sharing Sets and Modifying Robots

- All of the *Robotics Engineering Volume 1* lessons are based around the use of the Taskbot base robot model.
  - The Taskbot model takes between 20 minutes and 2 hours to build, depending on the experience level of the builder.
  - Each student team will need one robot.
  - In most cases, the model should be pre-built by student volunteers before the start date of the in-class activities. It is not recommended that the students spend class time building the robot from scratch, unless this activity aligns with your curriculum goals.
  - Once built, the robot base will generally not undergo any major modifications (however, there are a few activities where minor changes are made).
- As sensors are introduced, various sensor attachments will be built and added to the base model.
  - Instructions are provided for these attachments in the lessons that use them, and in the Building Instructions section of the main Robotics Engineering program.
  - Attachment building is short, and can be done in class if desired.
  - The attachments only need to be built once. If you have multiple class periods that share the robots, this means that only one will need to build them.
  - Some educational theory suggests that the act of building the attachments may lead to a better understanding of how the robot works; you may want to spread around the opportunities for different class periods to build the different sensor attachments.
- Some activities will require minor modifications to the robot base.
  - Students must be reminded to return the robot to the original configuration before leaving, otherwise subsequent periods will start with robots that are not correctly configured for the beginning of the activity.
  - For example, the Get in Gear activity requires that the robot start with a certain combination of gears on the wheels and motors. During the course of the activity, students change the gears to different combinations to see what effect this has on the robot's speed. Students must return the robot to the original gear configuration when the period ends, otherwise the next class will not have the correct gears to reference when they start the activity.
- Advanced activities will require significant modifications to the robot. This will require a different allocation of the robot resources.
  - Multi-day challenges, such as the End of Project Activity "Housekeeping Challenge," work best when the students are able to change various physical aspects of the robots (for example, attach a plow on the front of the robot to help push the "trash" into the corner for one of the challenges).
    - This will cause conflicts between different class periods which must share the same robots, if one group makes permanent changes to the robot that affect the way the shared robot base runs for the other group.
    - Being able to engineer a solution to a problem through a combination of physical and programming methods is a vital part of the learning experience, and should be supported if at all possible.

- Having additional parts available for student use can help with this problem. Groups can use “extra” parts to build attachments, and not modify the main robot base. Additional parts can be purchased through your distributor, or often collected through donations from parents in the school who have unused LEGO elements at home.
- Alternately, groups in different periods that share resources can be encouraged to “negotiate” a solution that is acceptable to all parties. Communication with peers and colleagues is another important skill that is vital in the workplace.

- Which robot? Which block type?
  - There are a few decisions that need to be made ahead of time about the robots and programming style that students will be working with during the activities.
    - One base robot model should be chosen as the starting point for all student groups. There are two choices here:
      - Taskbot – The preferred robot model for the *Robotics Engineering Vol. 1* activities. This robot has the necessary construction to work with all the lessons in *Robotics Engineering Vol. 1.*
      - Robot Educator Model (REM) – This is the base model for the 9797 Base Set itself, and is also featured in the sample programs found directly in the Programming Software. Its design is simpler, and it is easier to build. However, its straightforward construction prevents it from having a number of features (such as gears) which are central to some activities; therefore, it will work with some but not all of the lessons in *Robotics Engineering Vol. 1*.
    - An initial programming block style must be chosen. Once students have some experience in programming, they will be able to use both and choose the appropriate one for a given situation.
      - Motor Blocks – The Motor blocks are the explicit way of telling your robot what to do, by giving the motors individual commands. Motor blocks are the preferred way of teaching programming in the *Robotics Engineering Vol. 1* activities, because they allow students to see and control the conceptually important parts of the program in a consistent way.
      - Move Blocks – Move blocks are a simplified way of issuing movement commands to the robot, which can be as easy as a single block for simple movements. They are also more efficient than Motor blocks with regard to the sizes of programs.
      - Regardless of which approach students are first introduced to, students who will be programming the robot regularly should eventually become familiar with the options offered by both. The Move blocks can be introduced as a convenient shortcut and memory-saving option, or the Motor blocks can be added as a more direct method of controlling the robot’s motors.
      - More information on the difference between Motor and Move blocks can be found in the Motor vs. Move guide in the Preparation section of the Teacher CD, and the Student Motor vs. Move Guide in the Basics > Robot Behaviors section of the main program.
- Structure and Pacing of a Lesson

- Lessons are designed to be multi-day activities that students follow at their own pace (within limits).
- Every lesson comes with a “Lesson Starter” PowerPoint presentation which will introduce and review most of the necessary concepts and skills for the lesson.
- Class discussion is appropriate and encouraged whenever students have questions or issues that are relevant to the activity or subject. The role of the teacher in such discussion is not to judge, but to facilitate productive discussion. When needed, guide students toward the right answer by asking questions that will open avenues of discussion toward a successful outcome.
- Student groups can then proceed through the guided steps in the Projects section of the main Robotics Engineering program at their own pace. This allows for groups to move at a pace that is appropriate for them, neither too fast to understand, nor too slow to maintain interest. If a class is particularly uncomfortable with this, you may choose to go through the activity all together at once.
- Even so, because students learn at different paces within groups, it is important to make sure that all students are active, up to date, and contributing within their groups. It is just as detrimental to a student’s learning to do all the work (and not distribute the work efficiently) as it is for a student to be idle.
- Some groups will finish early. There are additional activities available for these groups in the “Continue” and “Extension” sections of lessons (where present), or groups may begin working on one of the optional “Anytime” activities. Anytime Activities are designed to fit in wherever there is free time in the class schedule (although they work best if students have seen certain other material first), and will introduce students to such fun and useful concepts as Human-Robot Interaction, Multitasking Programs, and Center of Mass.

- Assistants can help
  - Encourage students to both give and seek assistance from other groups in appropriate ways. There is much to be gained for all involved when one group of students helps another group to understand a concept that was holding them back.
    - The group that did the explaining reinforces their own knowledge, and gains a sense of pride in their accomplishment.
    - The group that received assistance is no longer stuck.
    - The instructor did not have to spend the full amount of time working with the stuck group, and instead had that time available to help another group who might have been having problems.
  - Helping is not the same as sharing answers.
    - Someone providing assistance should not simply give the solution to the person or group they are helping. Simply giving answers does not help the receiving group to understand the concept any better, and constitutes a form of academic dishonesty.
    - Discussing a concept, clarifying directions, checking calculations, comparing programs, and critiquing an approach or argument are all great ways to build understanding and solve problems that do not involve giving answers.
  - Sometimes a group will come up with a particularly innovative or effective way to solve a problem. Allowing the group to share their findings with the class will both allow them to take pride in their accomplishment and help the class to work better. This is similar to the function of professors giving seminars at the university level.

- What do I need to know before I can start teaching?
  - Review the material for the lesson.
    - Know the general order of steps and where students should be at the end of each class period.
    - Know the important points that you want students to notice.
    - Know which steps are designed to prompt discussion – some videos will intentionally lead students down what seems like an intuitive path, but ends in an unsuccessful outcome. These videos are always marked with red text in the final frame.
  - Know how to operate the NXT brick (including the basics of the NXT Software)