

Running Head: LEGO MINDSTORMS NXT

LEGO MINDSTORMS NXT: A Brief Introduction to Robotics

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## Abstract

In an effort to increase the number of Americans pursuing jobs in Computer Science and programming, the incorporation of LEGO MINDSTORMS NXT into schools is a solution. The NXT set is a robotics set that can be used in the classroom for teaching children the basics of robotics and programming. It does so by combining the familiarity of LEGO pieces with well designed robotic components and software to create a product that is a very powerful teaching tool and very appealing to use. As a way of increasing the overall knowledge of LEGO MINDSTORMS, an instructional package has been developed that is geared not towards students, but towards the educators that will teach them and many more.

## Introduction

In this project, I developed an instructional package for a course teaching the basics of LEGO MINDSTORMS NXT. The package consists of instructional materials, assessments, an instructor's manual, and a report. I chose this subject because I have a strong interest in LEGO MINDSTORMS NXT, and I wanted to choose a subject that I would actually enjoy teaching. I also just recently purchased an NXT set for personal use, and I developed two instructional videos for it in a course I took last semester. These videos have been received very well by the online community, and this encouraged me to contribute even more to this field. LEGO MINDSTORMS NXT is very important in the realm of education because it is such a powerful tool for kids and adults alike to learn more about robotics and programming. Through the development of this instructional package, I learned a great deal about instructional design.

### Problem Statement

Computer programming has historically been viewed as a highly technical subject area that is only pursued by a small percentage of Americans. This is highly evident when numerous reports arise stating shortages in the nation's technical workforce, with many blaming decreasing enrollment in Computer Science and Engineering programs in universities throughout the country. With technology continually increasing and international outsourcing already become a last hope for many companies, something must be done to alleviate this problem. An obvious solution is to increase enrollment in Computer Science programs, which will in turn increase the number of IT specialists and programmers in the workforce. One of the best ways to do this is to introduce computing to individuals at a young age in a way that can be appealing to them. One such product that can accomplish this is called LEGO MINDSTORMS NXT. It takes the concept of LEGO TECHNICs building bricks and components, which many children are familiar with, and combines it with an advanced robotics kit that contains sensors and a computing device that is programmable with software containing a visual programming environment. This software, known as NXT-G, opens up many doors for educators to introduce programming to children and teenagers in a way that can be highly appealing to them. However, like with any new software package, one of the best ways to learn it is through instruction. It is with this in mind that an instructional package is necessary—not for the children, but for educators who can ultimately affect thousands of children and teenagers around the country.

### Goal Statement

Given the LEGO MINDSTORMS NXT-G software and a simple robot to work with, the educators will be able to effectively use the software's many components to program the robot to

carry out a series of actions in a way that demonstrates their knowledge and understanding of the software. This knowledge and understanding will then serve as an empowering foundation for the introduction of robotics and programming to the educators' younger students.

### Learner Analysis

#### *Demographic Information*

The audience for this instruction will primarily consist of educators within elementary and middle schools that wish to introduce their students to computing, robotics, and programming.

#### *Entry Behaviors*

The audience will preferably already have a basic knowledge of computer programming and its applicability to many different situations. The instruction at times may refer to certain aspects of programming as it compares them to elements within the NXT-G software. These comparisons may not be fully understood to people with no programming background at all, but they should still be able to use the NXT-G software.

#### *Prior Knowledge of the Topic Area*

The audience will likely not have any specific knowledge of the NXT-G software. Previous knowledge will certainly enhance the learning experience, but it is not required nor is it expected.

#### *Attitude and Motivation*

With the intent on using their newfound knowledge as a means of teaching others, the audience will exhibit a positive attitude and high motivation towards the subject area.

*Learning Characteristics*

Due to the nature of the subject area and software environment, the audience will be open to learning through a mixture of lecture with labs and experimentation.

## Task Analysis

- Students can perform the following with the NXT hardware:
  - Identify different components (Verbal)
    - NXT brick, Sensors, Motors, Cables
  - Turn on NXT Brick (Psychomotor)
  - Connect NXT Brick to computer with USB cable (Psychomotor, Intellectual)
  - Use NXT Bricks buttons to navigate its menu options (Psychomotor, Intellectual)
    - Select program, Test Sensor, Enable Bluetooth
- Students can perform the following with the NXT-G software environment:
  - Create a new programming file (Psychomotor, Intellectual)
  - Open/close an existing programming file (Psychomotor, Intellectual)
  - Identify and switch between the different programming block palettes (Verbal, Psychomotor, Intellectual)
    - Common, Complete, Custom
  - Understand and use blocks from the follows categories (Psychomotor, Intellectual)
    - Common, Action, Sensor, Flow, Data, Advanced
  - Create a custom “My Block” programming block (Psychomotor, Intellectual)
  - Create a program (Psychomotor, Intellectual)

- Drag programming blocks onto the program sequence beam workspace (Psychomotor)
- Configure programming block settings (Psychomotor, Intellectual)
- Connect blocks together with input and output data wires (Psychomotor, Intellectual)
- Download program to NXT (Psychomotor, Intellectual)
- Manage NXT memory resources (Psychomotor, Intellectual)
- Use built-in Help guide as a technical reference (Psychomotor, Intellectual)

#### Performance Objectives

- Given the different hardware components of the NXT kit, the student will be able to identify its hardware components with 100% accuracy.
- Given an NXT Brick, the student will be able to successfully power it on in less than 10 seconds.
- Given an NXT Brick, proper USB cable, and easy access to computer and its ports, the student will be able to correctly connect the NXT Brick to the computer in less than 1 minute.
- Given an NXT Brick, the student will be able to navigate its menu options and perform a list of actions, each within 1 minute.
- Given the NXT-G software, the student will be able to create a new programming file as well as open and close existing files within 1 minute.
- Given the NXT-G software, the student will be able to identify, describe, and switch between the different programming block palettes with 90% accuracy.

- Given the NXT-G software, the student will be able to describe and use the different programming blocks from all of the programming block categories with 80% accuracy.
- Given the NXT-G software, the student will be able to create, save, and re-open a custom “My Block” programming block with 100% accuracy.
- Given the NXT-G software, a pre-built robot, and a task for it to perform, the student will be able to successfully create a new program by dragging programming blocks onto the program sequence beam, configuring the blocks’ settings, and connecting the blocks together with input and output data wires (if needed) within 30 minutes in such a way that, when downloaded to the robot, the robot performs the desired actions.
- Given the NXT-G software with an open program and an NXT Brick connected to the computer, the student will be able to download the program onto the NXT Brick within 30 seconds.
- Given the NXT-G software and an NXT Brick connected to the computer, the student will be able to logically and efficiently manage the NXT Brick memory resources with 100% accuracy.
- Given the NXT-G software, the student will be able to access the provided NXT Help guide and navigate to specific help sections with 100% accuracy.

### Instructional Strategies

A slightly modified version of Gagne’s Nine Events of Instruction is used, as explained further below. (Kruse)

#### *1. Gain attention*

For each lesson, demonstrate something about the NXT set that the students may find to be interesting. This can be a preview of something that will be taught later. An example for the first lesson is to present to the class a pre-built NXT robot that can drive in a square until stopped when it sees someone's hand.

## *2. Inform learners of objectives*

The objectives are listed at the beginning of each lesson handout, and they will be discussed in more detail by the instructor at the start of each lesson.

## *3. Stimulate recall of prior learning*

Present the students with a question about what they've used or done that may be similar to the upcoming objectives in the following lesson. For lesson 1, the instructor may ask students what types of technology they are currently using in their classroom environments. This gains attention through the use of classroom participation.

## *4. Present the content*

This will be carried out in a unique manner depending on the content being taught in the current lesson. For the first lesson, a PowerPoint slideshow is available to assist in the presentation and discussion of the content in the handouts. The other three lessons can be conducted in class without PowerPoint slides. This is possible because the teacher will actually be using the NXT-G software during the second lesson to demonstrate and describe the software.

## *5. Provide "learning guidance"*

Allow the students to inspect their school assigned NXT set as each component is discussed in class.

*6. Elicit performance (practice)*

Allow the students to construct the base build of the TriBot that is found in their NXT Set QuickStart Guide. Assignments are also given that reinforce the use of the NXT-G software and prepares them for the exam.

*7. Provide feedback*

After checking and grading the students work, whether it be a built robot or a typed program, look over the students' robots to ensure they are assembled correctly. Distribute lesson 02 reading material and issue Robo Center homework assignment.

*8. Assess performance*

Homework will be due and quiz over the current lesson will be taken at the beginning of the next class period.

*9. Enhance retention and transfer to the job*

Provide the students with examples and verbal explanations that use teaching and educating as an applicable subject area for many of the things learned.

### Media Selection

The media used in this course consists of comprehensive lesson handouts with reference images and diagrams, two NXT tutorial videos, and an NXT online tutorial developed by Yocum

(2006). These were selected because they are designed for a learner audience completely new to the NXT set. The NXT tutorial videos are short enough to be useful early in the course, and the NXT online tutorial is extensive enough to be used all throughout the course. While some of the content may be slightly repetitive between the videos, online tutorial, and actual in class lessons, this repetition will assist in how well the students retain the information.

### Formative Evaluation

This was conducted by first making a video recording of me teaching the first lesson and by emailing my instructional materials to a subject matter expert for review.

The video recording required at least two audience members, so I got my aunt and her two kids to sit in on my lecture. After watching my video, I feel that there are many aspects of my teaching that I need to improve upon. For instance, I was dependent on the PowerPoint slides to keep track of what I should have been talking about more than I should have been. I could have asked more inquisitive questions to help the students relate the information to their everyday lives.

For the subject matter expert review, I actually contacted a professor of robotics at a school in Oregon. He developed the NXT online tutorials that are seen by the class. He told me he would be more than happy to look over my materials. I sent them to him and he thoroughly reviewed my lesson materials and assessment tests. I included in my email to him a SME Course Review form (appendix), but he did not fill this out. Instead, he provided me with a large amount of valuable feedback and suggestions for how to modify my materials and test questions to be more applicable to the learner audience. From his comments, I learned that despite how much I may claim to know about LEGO MINDSTORMS NXT, I still have much to learn before I can

efficiently teach it to others. A recurring suggestion of his was to provide more visual elements to the assessment tests. Thinking back on it, I completely agree with him because the software that much of my instruction covers is highly visual due to its icon based design.

### Conclusion

Overall, the development of this instructional package has been a difficult challenge and educational experience. At many times I felt overwhelmed by the amount of work that had to be done. With regards to quality, the items I feel I did the best on are the instructional materials. In contrast, I feel I could have improved the most on the assignments I created for each lesson. If I could do this project over, I would go buy an LEGO MINDSTORMS NXT text book and develop my instruction around a set of lessons and content that has already been created by a subject matter expert. I spent the majority of my time developing what I came to call a “miniature text book” for my students to use during my course.

### Reflection

Throughout the development of this project, I learned that time is very precious. With only a month to do something that I feel should have been allowed at least two or three, I was under immense pressure from the very start. On top of this, other assignments such as research papers had to be completed in parallel with this instructional package.

During the development of my instructional materials, I found myself feeling like I was hardly making any progress. This is why I am now kicking myself for not immediately purchasing a text book over this subject area that I could have taught from. I do not feel that this would have been doing anything wrong because almost every class I have had has used a text book from an external source.

## References

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Appendix

**Subject Matter Expert Review Form**

REVIEWER:

DATE:

Please indicate a response by selecting a rating value. Provide additional comments as necessary.

N/A = Not applicable    3 = Neither agree/nor disagree

1 = Strongly disagree    4 = Agree

2 = Disagree                5 = Strongly agree

- |                                                                                                 |     |   |   |   |   |   |
|-------------------------------------------------------------------------------------------------|-----|---|---|---|---|---|
| 1. The instructional materials are suitable for the target audience.                            | N/A | 1 | 2 | 3 | 4 | 5 |
| 2. Reading level of the materials is suitable.                                                  | N/A | 1 | 2 | 3 | 4 | 5 |
| 3. The instructional materials are well organized.                                              | N/A | 1 | 2 | 3 | 4 | 5 |
| 4. The flow of learning is logical and easy to follow.                                          | N/A | 1 | 2 | 3 | 4 | 5 |
| 5. The instructional materials are accurate.                                                    | N/A | 1 | 2 | 3 | 4 | 5 |
| 6. The instructional materials are logical and thorough.                                        | N/A | 1 | 2 | 3 | 4 | 5 |
| 7. Included graphics and media are represented accordingly with the subject matter.             | N/A | 1 | 2 | 3 | 4 | 5 |
| 8. The instructional materials do not contain spelling, typographical, or grammatical errors.   | N/A | 1 | 2 | 3 | 4 | 5 |
| 9. The instructional materials are useful for the target audience to obtain intended knowledge. | N/A | 1 | 2 | 3 | 4 | 5 |

**COMMENTS/RECOMMENDATIONS:**