**Robotics with the Boe-Bot**

The Parallax Robotics with the Boe-Bot™ course is designed to build essential STEM related electronics, robotics, and programming knowledge while building essential 21st century skills. This Deeper Learning Guide identifies essential content for this course. It also helps you develop a clear and concise rubric that describes what it looks like when students demonstrate their understanding of the course content through hands-on inquiry and problem-solving. And a mapping guide has been provided to help the teacher and student identify which essential content will be required for each task.

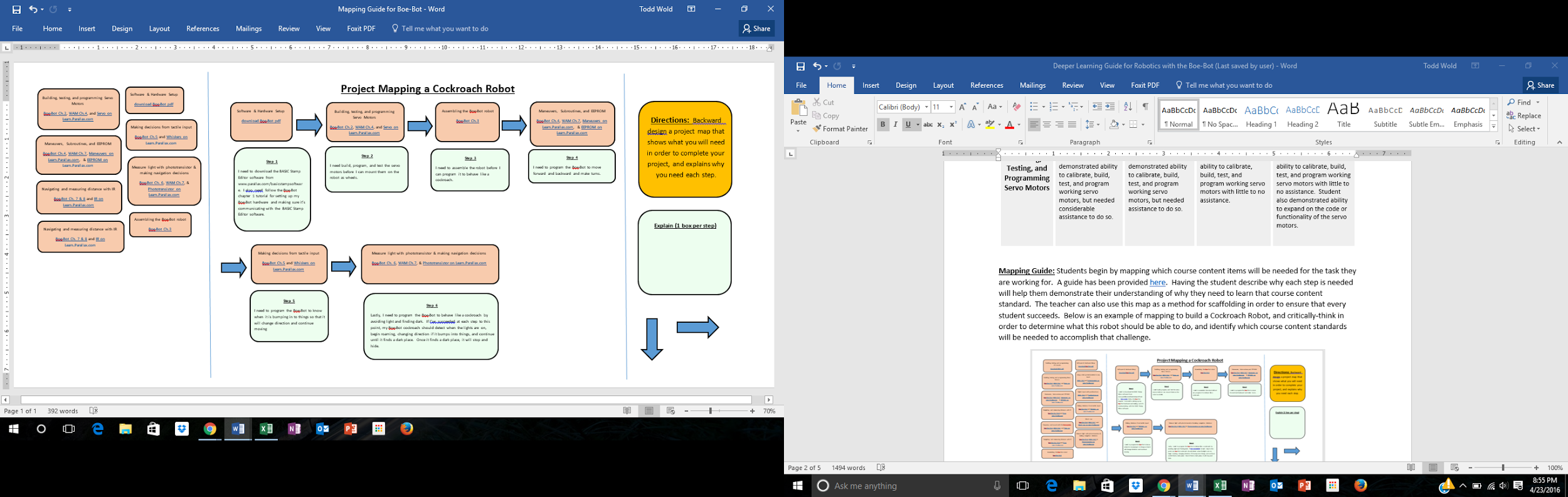
**Course Content:**

* + Software & Hardware Setup
  + Building, Testing, and Programming Servo Motors
  + Assembling the Boe-Bot
  + Navigating with the Boe-Bot
  + Frequency and Sound with the Piezospeaker
  + Programming Maneuvers, Subroutines, and EEPROM
  + Making Decisions from Tactile Input
  + Measure Light with Phototransistor & Making Navigation Decisions
  + Navigating and Measuring Distance with IR

**Standards Alignment**: We recommend using a rubric that is aligned with the course content. We have provided an example for reference, but feel strongly that generating your own rubric for your course will help you align it best for your program and standards. You are welcome to refer to the [Parallax Recommended Assessment and Grading Practices](https://docs.google.com/document/d/1b6AOMPaoPqzXMb7fxCQ63514vC60OuHlx-yRMlGtwtk/edit#heading=h.gjdgxs) document as well. You might want to begin with something like this:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Rubric** | **1** | **2** | **3** | **4** |
| **Software & Hardware Setup** | **Below Standard:**  Student needed assistance to follow technical manual in order to setup hardware and install software, and is not able to articulate how s/he did so. | **Approaching Standard:**  Student needed assistance to follow technical manual in order to setup hardware and install software, but is able to articulate how s/he did so. | **At Standard:**  Student demonstrated ability to follow technical manual in order to setup hardware and install software with little to no assistance and can articulate how s/he did so. | **Above Standard:**  Student demonstrated ability to follow technical manual in order to setup hardware and install software with little to no assistance, can articulate how s/he did so, and helped others do so as well. |
| **Building, Testing, and Programming LED Circuits** | Student demonstrated ability to build, test, and program working LED circuits, but needed considerable assistance to do so. | Student demonstrated ability to build, test, and program working LED circuits, but needed assistance to do so. | Student demonstrated ability to build, test, and program working LED circuits with little to no assistance. | Student demonstrated ability to build, test, and program working LED circuits with little to no assistance. Student also demonstrated ability to expand on the circuit and/or code. |
| **Building, Testing, and Programming Servo Motors** | Student demonstrated ability to calibrate, build, test, and program working servo motors, but needed considerable assistance to do so. | Student demonstrated ability to calibrate, build, test, and program working servo motors, but needed assistance to do so. | Student demonstrated ability to calibrate, build, test, and program working servo motors with little to no assistance. | Student demonstrated ability to calibrate, build, test, and program working servo motors with little to no assistance. Student also demonstrated ability to expand on the code or functionality of the servo motors. |

**Mapping Guide:** Students begin by mapping which course content items will be needed for the task they are working for. A guide has been provided [here](https://drive.google.com/drive/u/0/folders/0B08VpOZrQJ21M201Z085YmpIa3c). Having the student describe why each step is needed will help them demonstrate their understanding of why they need to learn that course content standard. The teacher can also use this map as a method for scaffolding in order to ensure that every student succeeds. Below is an example of mapping to build a Cockroach Robot, and critically-think in order to determine what this robot should be able to do, and identify which course content standards will be needed to accomplish that challenge.



**Assessment:** Refer again to the [Parallax Recommended Assessment and Grading Practices](https://docs.google.com/document/d/1b6AOMPaoPqzXMb7fxCQ63514vC60OuHlx-yRMlGtwtk/edit#heading=h.gjdgxs) for some thoughts on formative and summative assessment. How can you scaffold the learning of each student as they learn while doing? And, how will you know that they know and what will you do when they don’t?

**Taking the Learning Deeper through Project-Based Learning**

Hands-on inquiry and problem-solving are effective methods for teaching course content while developing critical-thinking skills. We at Parallax challenge you to take your students’ learning even deeper. We have modeled after The Buck Institute’s Gold Standard Project-Based Learning to help you prepare your students for college, career, and life by taking their learning even deeper.

**Design Thinking**: Rather than telling the students what their task will be, Project-Based Learning (PBL) has the students design their own project that has a real-world purpose, using course content from the rubric. For example, a student might decide they want to design a spy-bot for surveillance, or a delivery-bot for providing emergency supplies, or a search and rescue bot to help with earthquake or avalanche victims.

**Driving Question:** In PBL, the student would begin by developing a driving question. For instance, they may ask, “How can I build a robot that will deliver emergency supplies?”, “How can I design a robot that will search for live victims of an earthquake?”, or “How can I design a robot that conducts surveillance?” The key here is that student is choosing how and where to apply the course content in order to design something with real-world application.

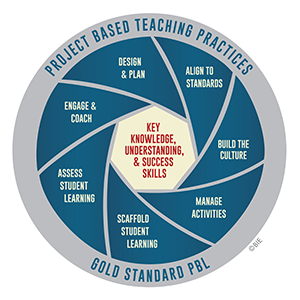
**Backward Mapping:** Students would need to [backward map](https://drive.google.com/drive/u/0/folders/0B08VpOZrQJ21M201Z085YmpIa3c) their robot or device by determining which rubric items they will need to add by using the Project Mapping Guide. They can use the same mapping guide as above, except in PBL they are deciding which course content to include and defending why they would need to include it. On a side note, it may take more than one robot-project in order for each student to demonstrate their understanding of every topic within the rubric.

**Elements of Gold Standard PBL:**

Essential Project Design Elements: Gold Standard Project-Based Learning:

* Challenging Problem or Question
* Sustained Inquiry
* Authenticity
* Student Voice and Choice
* Reflection
* Critique & Revision
* Public Product

**Project-Based Teaching Practices: Gold Standard Project-Based Learning:**

* Design & Plan
* Align to Standards
* Build the Culture
* Manage Activities
* Scaffold Student Learning
* Assess Student Learning
* Engage & Coach

Most of the elements of Gold Standard PBL have already been addressed. There are two more elements though that need to be addressed.

**Building the PBL Culture:** In addition to student voice and choice, reflection, and sustained inquiry, Gold Standard PBL requires an environment of collaboration, communication, creativity, and critical-thinking. How can you build a culture that encourages these as well as student self-management and critique & revision in order to help your students take their own learning deeper?

**Public Product:** And lastly, Gold Standard PBL increases rigor through having a real-world public product that is demonstrated outside of the classroom. When your students demonstrate and explain their product, they are mastering verbal, written, and technical literacy skills. We would encourage you to think beyond the science fair. Perhaps an exhibition night would work, but how can you invite industry partners from the community to help assess the projects? What if the robotic hand was presented to a group of amputees and professionals that work with them? The possibilities of connecting with the community and bring recognition to your students and your program are endless.

**Beyond Gold Standard PBL**

**Integrating Core Standards and Makerspaces:** We at Parallax feel that we have provided a phenomenal series of content and robots/electronics/UAVs to fully support any electronics, robotics, or UAV course K-15. That being said, we also encourage extending student learning beyond. For instance, you could utilize our program to enhance your core content standards such as [Common Core English and Math, Next Generation Science Standards, Career Technical Education Standards, and 21st Century Competencies](https://drive.google.com/drive/u/0/folders/0B08VpOZrQJ21M201Z085YmpIa3c). You could also use our program as the foundation for your maker space. For instance, how could your students use CAD, a 3D printer, a CNC, or a laser engraver, to customize, enhance, and extend beyond? How could your students use the foundational content knowledge they learned in this program by extending it to wearable micro-circuits such as e-textiles? Or how could they innovate and use a mindset of design-thinking to develop that which has yet to be imagined? The opportunities are endless after your students have successfully learned the Parallax program as a springboard to extend their learning in ways that you and I wouldn’t even consider!

**Professional Development Opportunities:** Contact us at [education@parallax.com](mailto:education@parallax.com) if you are looking for professional development on the following:

* Teaching robotics, electronics, and programming through inquiry-based learning and problem solving
* Vertically aligning your program to begin with microcontrollers and move through quadcopter UAVs.
* Moving your program from inquiry-based learning and problem-solving, to Project-Based Learning
* Aligning your STEM, CTE, or Maker Space program with Common Core English and Math, Next Generation Science Standards, Career Technical Education Standards, and 21st Century Skills.