

Introduction: Math Instructor's Guide

Sometimes innovation is the rediscovery of what we already knew. Two things we know:

- Building is an historic use for math.
- People learn what they need to know.

We need to use all the tools we have to do a better job of demonstrating the real world applications of math. This Math Guide is part of a program called *Building to Teach* designed to improve math instruction by helping instructors teach math while building. It's not a new technique, but we need to use it more. If you're a craftsman, we want to make you a better math instructor. If you're a math instructor, we want to make you a better craftsman.

Bevin's Skiff is a simple, flat-bottomed skiff. Derived from traditional designs, it was specifically designed to be used as a teaching tool—both during its construction and its use.

Many versions of Bevin's skiff can be built:

- Card Stock Model — Made from an 8.5" x 11" sheet of cardstock, this scale model is built with the same pieces as the full size and remote control boats. It's a quick, excellent introduction to the building process. There is also some math involved.
- Pinewood Derby" Sailing Model — This simple model is quickly built and can be used to introduce measuring, fractions, basic geometry and sailing.
- Remote Control Sailing Model — This 18" model is built very similarly to the full size skiffs.
- Full Size Plywood Skiff — Made with marine grade plywood and available as a kit from the Alexandria seaport Foundation. www.alexandriaseaport.org
- Full Size Renewable Skiff — Made out of renewable/ recyclable materials. It can be disassembled to be built multiple times by multiple groups.

Connections between boat building and math can be made by building any of these projects. The more involved the project, the greater the teaching opportunities. This Guide is written for building the full sized, plywood version of the boat. Most of the building steps and related math apply to the Full Size Renewable Skiff and the Remote Control Sailing Model.

Bevin's Skiff Building Manual and Math Instructors Guide

The math skills taught during the boat building and accompanying hands-on math exercises, complement math instruction in the 4th, 5th, 6th, 7th and 8th grades, as well as Algebra and Geometry.

This Math Instructor's Guide complements *Building To Teach's* instructor training and resources. *Building To Teach* offers both on-line and in-person training. Much of this training, and many of the resources, are available on line. You can apply for the training and learn more about *Building To Teach* by going to the website: www.buildingtoteach.org.

This is both a Math Instructor's Guide and a Building Manual. Even though you're probably reading it because of the math, remember that the most important thing is the safety of your students while building the boat. Be sure you read and understand all the building instructions—particularly the safety notes at the end of this introduction. Use a printed out copy of the Guide as your notebook. There should be enough “white space” for you to write down what you learn.

These materials are the result of almost 20 years experience building boats and teaching math. Even so, every time another boat is built students, teachers and volunteers add something new to the process. So, this Instructors Guide is a living document that needs your input to improve. Please send in comments and improvements.

Anybody using this manual is strongly encouraged to join the online Building To Teach community. Use our resources and help make them better at www.buildingtoteach.org.

How to Use this Guide

This Instructor's Guide is designed to help you teach math while building the Bevin's Skiff. The book is divided into units that cover each stage of the building process. Each unit starts with the needed vocabulary. The building steps are on the left hand side of the page in a serif typeface. On the right hand side of the page, in sans serif type, is a list of the related math skills, instructor tips about how to present those skills, suggested hands-on exercises and other resources that may be helpful. There are contextual “Problems of the Day” linked to the math skills and designed as a common reference point for instructors, students and tutors—some of whom may be online. You'll also get occasional STEM (Science, Technology, Engineering and Math) Notes that talk about other science, technology and engineering skills that can be discussed and taught.

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Read the Instructor's Guide all the way through before you start building and teaching. Figure out what skills you're going to teach—what's appropriate for your group; how you want to teach them and how you want to measure your students' achievement.

You can build directly from this Guide, or you can get a separate Building Manual with larger illustrations by contacting the Alexandria Seaport Foundation at asoffice@alexandriaseaport.org

Math Subjects and Skills

The math subjects covered include: Operations with Whole Numbers, Fractions, Decimals, as well as Measuring, Basic Geometry, Calculating Area and Volume, and Algebra. Each subject has been broken down into math skills, which can be observed in a shop.

Coverage of Common Core Standards for Mathematics

Building Bevin's Skiff and using the accompanying Hands-On Math Exercises can introduce and help teach the following approximate percentages of the national Common Core Standards for Mathematics.

- Fourth Grade—90%
- Fifth Grade—90%
- Sixth Grade—80%
- Seventh Grade—75%
- Eighth Grade—60%
- Algebra—50%
- Geometry—90% (excepting proofs)

Teaching in the boat shop allows you to do things critical to good learning:

- Treat each student as an individual.
- Set and communicate concrete goals and objectives.
- Teach in an environment that reflects the rewards and penalties of real life.
- Teach math contextually.
- Motivate the student.
- Create a trusting community of boat builders (students, instructors and volunteers).
- Measure and evaluate individual and program success.

Appendices

Make sure you carefully look through the Appendices. Rather than load up this introduction with lists of math skills, related Common Core Mathematics Standards, Hands-On Math Exercises as well as thoughts on how we like to teach math are in the Appendices. So, read them.

Appendix 1 - Standards/ Skills/ Exercises/ Projects Index

This chart graphically demonstrates the linkages between measurable math skills, the national Common Core Standards for Mathematics, the Hands-On Math Exercises, related Problems of the Day, and boat building projects—such as the different versions of Bevin's Skiff. It is a critical tool for linking together the instructional resources available through *Building To Teach*.

Appendix 2 - Common Core Math Standards by Grade

The relevant national Common Core Standards for Mathematics are listed for grades 4 through 8, as well as Algebra and Geometry.

Appendix 3 - Math Skills (Competencies)

The math skills are designed to be competencies measurable in a shop setting. For example, you will know if a student can, “Add and subtract mixed numbers,” or “Read a ruler to a usable tolerance: 1/16”, 1/10” or 1mm.” Most of the *Building To Teach* materials, Hands-On Exercises, Problems of the Day and project building steps, are linked to the math skills (see Appendix 1). It's up to each building group to select the skills from the list that they want to teach. These math skills form the basis of *Building To Teach's* online competency tracking. Using *CanDo* software, each building group is able to measure and track their students' progress in their selected skills. (This software is available to groups who have completed *Building To Teach's* in person training.)

Appendix 4 - Hands-On Math Exercises

Hands-On Math Exercises are designed to introduce and reinforce math skills. Using simple tools and inexpensive materials students can do these exercises in the shop or in a classroom. Some are designed to be “one time” experiences—finding the heights of unknown objects. Others are designed to be repeated often—the Magic Ruler and the Multiplication Table. The exercises are linked to specific skills. Pick your exercises when you identify the skills you intend to teach. An incomplete list of suggested exercises are listed with the building steps. You'll add, or subtract, from those suggestions.

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Appendix 5 - *WoodenBoat Magazine*, issue 224, Getting Started in Boats Volume 32, "Building A Skiff to Teach Math"

It's a decent summary of what math can be taught while building a simple boat and why it's important. Hopefully, it will be useful when explaining the project to others. Sections include: Why build a boat to teach math?, What math can you teach?, Measuring, Ratios, Lines and Planes, Angles, Isosceles Triangles, Right Angles, Algebra, Integrating the boat project into the classroom, Using models to help teach.

Appendix 6 - Elements of Instruction

Compiled by the Alexandria Seaport Foundation's math instructors, this list distills the elements critical to student success when teaching in a shop setting.

Appendix 7 - Fundamentals of Teaching Hands on Math

A few fundamental concepts govern a whole lot of computations. A few fundamental computation skills and math facts make those computations easier and more accurate. If you're going to teach your students "ten things", this is where to start.

Appendix 8 - Bevin's Skiff Published Resources

Books, magazines and other useful materials.

Appendix 9 - Glossary

Boat Terms, Tool Terms and Math Terms

Appendix 10 - Materials, Material Suppliers, Tools and Kit Packing Lists

Math Instructors Guide Conclusion

The Instructors Guide and all the related Building To Teach materials contain a lot of information. Don't expect to use all of it at the same time. The objective is to provide math instructors with good teaching tools. Which ones get used depends upon the job. Many times you'll have different levels and types of learners in the same group. Choose the skills and related hands-on exercises, STEM notes, etc... that make sense for the students.

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Technical Support for Math Instruction

After you've looked through everything, in this Guide and online, if you still have questions, contact Joe Youcha at jyoucha@BuildingToTeach.org.

Instructor's Guide Acknowledgement

Bevin's Skiff was first designed and built in 1997. After the experience of running over 100 community boat building projects, Alexandria Seaport Foundation staff and volunteers sat down and figured out a boat that could be a good teaching tool, good to build and good to use. Since then, ASF staff and volunteers have written and reviewed the Building Manual, Hands-On Exercises, Math Skill lists and this Math Instructors Guide. If I tried to list everyone involved, I'd know I'd miss someone. Suffice it say, the credit is theirs; the errors are mine.

Best Regards,
Joe Youcha

Building Manual Introduction

Capacity

The recommended capacity of Bevin's Skiff is 450 lbs (the capacity with 8" of freeboard), equivalent to three 150lb people.

A Word on Safety- (Review with students)

- You're brought into this world with two eyes, two ears, ten fingers and ten toes; make sure you keep them.
- When you are using a tool, keep your hands behind the cutting edge of the blade.
- Use safety glasses, hearing protection and latex gloves.
- Most importantly, use common sense.
- It is your responsibility to know how to use your tools. If you don't know how to do something, ask someone who does.

This boat is designed to be easy to build, but nails can fly through the air when you try to hammer them. Hammering is noisy and polyurethane adhesive (e.g. Sikaflex or 3M 4200/5200) is not totally benign. Epoxy can sensitize your skin and cause a rash. So be smart. Also be neat! Clean up squeezed out adhesive before it dries! Life (and painting) will be easier.

A Word About This Manual

The tone of this manual reflects the importance we put on safety.

- When we say, "Don't Be Stupid!" we mean it (and we're talking from personal experience...)
- Read the directions all the way through before you start.
- Familiarize yourself with the pictures, drawings, parts list and tools/supplies list.
- Read the directions for each step all the way through, before you mark or cut the wood.
- These instructions are written to be used as you build this boat. If something is unclear, think about how the piece will fit in the boat.
- Build the cardstock model first. It's available at both www.alexandriaseaport.org and the *Building To Teach* training website. It's a good introduction to how the boat parts fit together.

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You might read these instructions all the way through at the beginning and say, "I have no idea what he's talking about. I'll never be able to build this. This isn't simple." Believe us, it is simple. A wonderful boat builder, Pete Culler, used to say, "Experience starts when you begin." So don't be afraid to get started. Remember, it's only a boat. A journey of 1,000 miles starts with one step.

Building Technical Support

We are available to answer questions about these boats, but remember, we're a small outfit! The best way is via email. Our address is asoffice@alexandriaseaport.org. You can reach us by phone, during US East Coast work hours, at 703 549 7078.

For math support, contact Joe Youcha, jyoucha@BuildingToTeach.org

Building License

Purchasing plans allows you to build two boats. If you want to build more, you need to contact us.

Kit Builders vs. Plan Builders

Kit builders receive everything they need to build the boat. Plan builders need to obtain all the materials and make all the boat parts. There are both a materials list and a suppliers list in Appendix 10. Kit builders should also familiarize themselves with all the pieces before they get started. There will be several places in the building process where plan builders will need to fabricate pieces and kit builders won't.

Math Guide v. Building Instructions

This is a Math Instructors' Guide. So, laying out and cutting the boat parts is the last unit. If you're a plan builder, you'll be doing that work first.

Epoxy and Polyurethane Adhesive

You will be using two types of glue. Epoxy (e.g. MAS) and a polyurethane adhesive (e.g. Sikaflex). Neither likes to come out of clothes. There are golden rules for both.

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Epoxy

- Use in a warm place, 40 degrees F or over.
- Measure your resin and hardener accurately. The ratio must be correct.
- Stir the resin/ hardener mix well for at least a minute before you add wood flour filler. Mix in the filler well for at least a minute.
- Don't mix until you need it and only mix a little more than you think you'll need.
- Read the manufacturer's instructions.
- You can clean up wet epoxy from your hands and tools with ordinary house vinegar or "GOJO" hand cleaner.

Polyurethane

- Use in a warm place, 40 degrees F or over.
- Make sure you remove the metal cap from the rear of the tube, if there is one, and cut the nozzle and punch a hole in the nozzle seal with a 16d nail, or other long pointed object.
- Release the pressure in the caulking gun after each use. Otherwise more adhesive will end up on the floor than in the boat.

Let's Get To It!