Hands on History: A Resource for Teaching Mathematics
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This volume was created on the premise that hands-on experience with mathematical instruments and a knowledge of their historical context have a significant role in the enhancement of student learning in mathematics. Hands on History, edited by Amy Shell-Gellasch, consists of fifteen contributions on this theme by thirteen authors and co-author pairs, followed by a sixteenth section by Amy Ackerberg-Hastings and Peggy Kidwell on exhibiting a collection of such instruments. All of the authors are mathematics educators and/or researchers.

Each article deals with the historical context of one or more mathematical models or devices, their construction, and their use in the classroom. The students for whom these applications are intended are primarily undergraduates, although a number of the devices are well-suited for use in the high school or even middle school classroom as well. Some of the articles describe how an instrument was originally constructed and others provide directions for construction by an instructor or by students. An exception is Brian J. Lunday’s article on French curves (named for the creator not the country), which discusses their history and use, but does not consider construction of the curves beyond describing the material from which they were and are manufactured. None of the physical objects described is a contemporary ‘manipulative’; rather, all are historical objects that were used as working tools (such as the Roman surveying instruments described by Hugh McCague) or as classroom models in previous times (such as the Olivier string models described by Shell-Gellasch and Bill Acheson).

Some of the objects arise from ancient ideas and are constructed based on inferences as to the physical objects that may have been used. Examples are David Zitarelli’s cut-and-move ‘proof’ of the Pythagorean Theorem from 6th-century Greece and a coloring ‘proof’ from the Nine Chapters. By contrast, Katherine Inouye and Kim Plofker’s contribution on “The Cycloid Clock of Christiaan Huygens” describes its construction based on existing drawings and models. The volume also includes contributions from James Evans (on the equatorium from Greek astronomy), J.L. Berggren (on sundials), and a second article by Shell-Gellasch (on the solution of quadratic and cubic equations).

There are several 19th-century objects described. Since these items are still in existence, the authors consider how to replicate or create simple working versions of them. Included among these are Shell-Gellasch and Acheson’s article on the Olivier string models, and Robert L. Foote and Ed Sandifer’s section on planimeters (mechanical instruments that measure area); the latter includes directions for making a polar planimeter from Tinker Toys!

Some of the constructions, including the Tinker Toy planimeter, are quite simple and can be done by students. Also feasible is the sturdy set of Napier’s bones made from an instructor-provided paper template and glued to tongue depressors, as described by Joanne Peeples. The rectangular protractor that Amy Ackerberg-Hastings describes is an easy-to-make replication of a 19th-century device still in existence. Some models are meant to be constructed by the instructor and brought fully made into the classroom. For example, Fred Rickey describes the carpentry project of making a brachistochrone. The most elaborate are the Olivier string models and the medieval labyrinths that Hugh McCague constructs.

A number of contributions focus on the mathematical justification for the instrument under discussion. In “Historical Mechanisms for Drawing Curves,” Daina Taimina looks at linkages and other historical mechanisms used for drawing curves and designing machine motion. Well-illustrated with drawings, photographs, and diagrams, the article examines the history thoroughly from the Greek geometers who sought mechanical means to solve geometric problems to the engineers who used these ideas in arms design during World War II. Taimina describes many of the devices in great detail and shows the mathematics that justifies the result. The author does not provide specific classroom applications, but does cite sources that do so.

In recent years, many American colleges have begun the use of ‘learning communities’ in which small groups of students enroll in two or more courses related by a common theme. A number of the contributions to this volume have ideas that would be applicable in pairs that link a mathematics course with an appropriate course in art, history, engineering, archeology, astronomy, architecture, physics or even Latin. Perfect for many linked courses is McCague’s “Learning from the Roman Land Surveyors: A Mathematical Field Exercise.” He discusses the Romans’ highly developed system of land surveying and its role in the expansion and maintenance of the Roman Empire. The instruments under consideration are the groma, which was used for sighting right angles, and the decempeda, which was a measuring rod of ten Roman feet. His directions for constructing the groma are based on a museum model that was in turn...
based on historical texts and archaeological evidence. Instructions are given for using these instruments in a number of surveying exercises. He suggests that the law of cosines be used to check the accuracy of the measurements obtained. I passed this article to a colleague who teaches high school Latin. She used some of the information in the ‘Roman culture’ aspect of her course and has a small group of students who are working to construct a groma—high school students are always in search of ‘extra credit’ projects.

Throughout this book the editor has sustained the concept of augmenting the teaching of mathematics using historically-motivated physical objects by having the contributions of each author adhere to a discussion of the construction of the item in question, its historical context, and its use in the classroom. The level of scholarship is high, and all contributions are appropriately documented and are illustrated with drawings, photographs, and diagrams. Hands on History would be a good addition to the library of anyone who wishes to enhance the mathematics classroom experience with either history or hands-on work.

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