CSAwesome: a free curriculum and ebook for Advanced Placement Computer Science A (CS1 in Java)

Beryl Hoffman
Elms College
Chicopee, MA
hoffmanb@elms.edu

Barbara Ericson
University of Michigan
Ann Arbor, MI
barbarer@umich.edu

ABSTRACT

This hands-on virtual workshop will introduce high school and college instructors to CSAwesome, a free Java curriculum and ebook at http://course.csawesome.org for the Advanced Placement (AP) Computer Science (CS) A course. This course is equivalent to a college-level CS1 course in Java. The free ebook on the Runestone platform includes executable Java code examples and problems, mixed-up code (Parsons problems), multiple-choice problems, coding challenges, and support for collaboration.

The workshop will be led by the CSAwesome ebook authors. All workshop activities will be online, featuring live demonstrations, participant activities and breakout rooms differentiated depending on the participants' Java experience. Workshop participants can use a laptop or tablet to access the online curriculum. Participants will also learn how to create a custom course on the Runestone platform and use the instructor's dashboard to view student progress, create and grade assignments, contribute to the question bank, and use an interleaved spaced practice tool. We will also discuss online and hybrid teaching and engagement strategies.

CCS CONCEPTS

• **Social and professional topics → Computing education**.

KEYWORDS

CSAwesome, AP CSA, CS1, Java, curriculum,broadening participation, online teaching

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1 INTRODUCTION AND SIGNIFICANCE

CSAwesome at http://course.csawesome.org [3] is a free Java curriculum for AP CSA (equivalent to CS1) that is an approved College Board curriculum. The curriculum includes a free ebook that was developed in 2019 by adapting Ericson's CSA Java Review ebook on the open-source Runestone platform [9]. The free ebook on the Runestone platform includes executable Java code examples and problems, mixed-up code (Parsons problems), multiple-choice problems, coding challenges, and support for collaboration.

The curriculum is designed to broaden participation in CS and transition students from AP Computer Science Principles, which is equivalent to a CS0 course and is often taught with a blocks-based language, to AP CSA and textual programming in Java. It uses a variety of techniques such as scaffolded problems and collaborative learning to support this transition. Teacher lesson plans and resources are freely available.

The CSAwesome curriculum has been successful in its first year with over 10,000+ registered users and over 1600+ teachers in the Teaching CSAwesome professional learning community and google group which allows access to teacher resources. The CSAwesome curriculum has helped teachers adapt to online and hybrid teaching during the COVID-19 pandemic.

2 WORKSHOP AGENDA

This 3 hour workshop will be online and hands-on with the following proposed agenda of activities.

- Introduction to the free CSAwesome curriculum and ebook (15 mins)
- Creating a custom course on Runestone (15 mins)
- Intro to object-oriented programming with executable Java code and Parsons problems (45 minutes). Teachers will be divided into 2 breakout groups according to their Java expertise for the activities.
  - Unit 2 intro to objects with turtles activities and coding breakouts for new to Java teachers.
  - Unit 5 Writing classes and Unit 9 Inheritance activities and coding breakouts for experienced Java teachers.
- Checking student progress on Runestone (15 mins)
- Break (15 mins)
- Online engagement, collaborative coding and pair programming strategies (breakout rooms) (30 mins)
- Creating and grading assignments on Runestone (30 mins)
- Q/A, Wrap up (15 mins)

All activities will be online, featuring live demonstrations, participant activities, and breakout rooms (if available). This workshop is targeted towards high school AP teachers and college CS1 instructors and can handle a large audience. Some of the workshop activities will be differentiated depending on the participants' expertise as new to Java or experienced in Java. Workshop participants will need a computer or tablet with an internet connection to use the online curriculum and participate in the workshop.

The workshop will be led by the CSAwesome ebook authors:

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- Dr. Barbara Ericson is an Assistant Professor of Information at Michigan University and the creator of adaptive Parsons Problems and many ebooks on Runestone.
- Dr. Beryl Hoffman is an Associate Professor of Computer Science at Elms College and a curriculum developer and researcher for Mobile CSP and CSAwesome.

3 CSAWESOME CURRICULUM

The CSAwesome curriculum covers the following topics in table 1, following the College Board's 2019 AP CSA unit layout and learning objectives [2].

Table 1: AP CSA Units

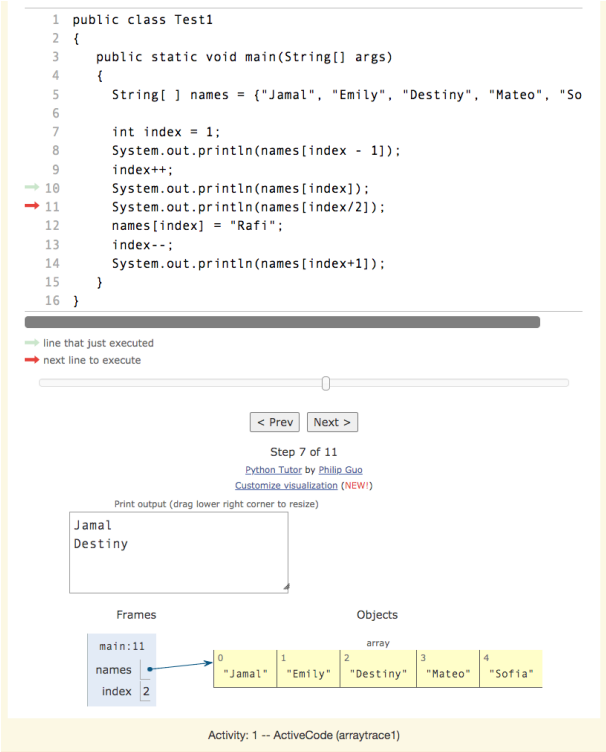
Unit	Name	Topics
1	Primitive Types	variables, expressions, operators
2	Using Objects	constructors, methods, strings
3	Conditionals	Boolean, control flow, comparing objects
4	Iteration	while loops, for loops, nested for loops
5	Writing Classes	constructors, accessors, mutators
6	Arrays	creating, traversing, enhanced for loop
7	ArrayList	traversing, searching, sorting
8	2D Arrays	creating, traversing
9	Inheritance	constructors, overriding, polymorphism
10	Recursion	tracing, searching, sorting

The goals of CSAwesome are to broaden participation in the AP CSA course by supporting students and teachers as they transition from AP CSP (CS0) to AP CSA (CS1) with inclusive curriculum design and teaching practices. The curriculum is based in an online interactive ebook with scaffolded interactive coding problems with frequent opportunities for creativity and collaboration. The ebook contains worked examples in the form of executable and modifiable Java code followed by practice problems. All active code problems in the ebook now have a Code Lens button which shows the Java visualizer for that code. This allows a student to step through the code line by line and see the variables in memory as shown in Figure 1.

The curriculum includes LOGO-style Turtle code to introduce object-oriented programming and a Picture Lab from media computation [10], which covers two-dimensional arrays by having students write code to modify image pixels. The ebook compares code blocks with Java code when new concepts are introduced, to build a bridge between the previous context (CSP) and the new context (CSA). This approach has been effective in mediating the transfer of knowledge between two areas [4].

There is also support for pair programming, collaborative work, and creative open-ended projects. These have been shown to improve student retention, confidence, and success in CS, especially among underrepresented students [11, 12]. Runestone also contains

Figure 1: The Java code visualizer/stepper



an innovative practice tool that supports deliberate and spaced practice [14].

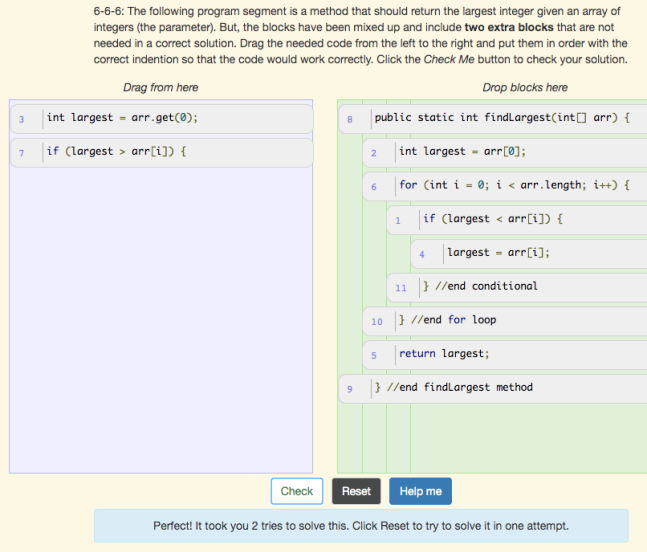
3.1 Parsons Problems

The curriculum includes mixed-up code problems also known as Parsons problems [13]. In a Parsons problem, the user puts blocks of mixed-up code in order to solve a problem as shown in Figure 2. This type of problem may be particularly helpful in the transition from blocks-based to text-based programming. Parsons problems can also include incorrect blocks known as distractors and may also require the learner to correctly indent the code blocks.

Adaptive learning modifies the difficulty of problems to scaffold a learner and attempts to keep the learner in the zone of proximal development (ZPD) [1], which is just beyond what the learner can accomplish unassisted, but can accomplish with help. In the CSAwesome course, there are two types of adaptations for Parsons problems: intra-problem and inter-problem. In intra-problem adaptation if the learner is struggling to solve the current problem it can dynamically be made easier by removing distractors or combining blocks. In inter-problem adaptation the difficulty of the next problem is modified based on the learner's performance on the last problem. These adaptive problems scaffold learning and have the potential to ease the transition from block-based coding to text-based coding.

There is evidence that most learners enjoy solving Parsons problems [13], many attempt to solve them [7], solving Parsons problems is more efficient for learning than writing the equivalent code

Figure 2: An example Parsons problem with distractor blocks on the left and the correct solution on the right. Note that the blocks are both in the correct order and indented correctly.



or than fixing code with errors [6, 8], and that learners are twice as likely to correctly solve adaptive versus non-adaptive Parsons problems [5].

3.2 Teacher Resources

The CSAwesome curriculum supports new to CSA teachers with comprehensive teacher resources. Each lesson in the book has a corresponding lesson plan and unplugged activities and worksheets developed by experienced CSA teachers. The lesson plans include the CSA learning objectives and a detailed guide with timings for the learning activities with a hook, direct instruction, guided practice, collaborative work, and reflection sections. They also contain inclusive teaching strategies and support for differentiation and teaching tips to support the transition from CSP to CSA.

The Runestone platform allows teachers to create custom courses, use the instructor's dashboard to view student progress, create and grade assignments, and use and contribute to the question bank.

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