

# *E Pluribus Unum*: Multi-cultural Foundational Computer Science Flashcards

## System Overview

*E Pluribus Unum* (out of many, one) is an online flashcard website consisting of multiple-choice questions typical for a pre/post-test for a high school foundational computer science course or the first semester of an AP Computer Science Principles class.

The main difference between *E Pluribus Unum* (EPU) and other flashcard systems with similar questions is that students can experience a flashcard learning session using questions and answer explanations in a “culture” that most appeals to them. Students can also take flashcard learning sessions that mix in questions from a variety of “cultures” but still have the same underlying code and teach the same underlying computer science principles (*E Pluribus Unum*)

*E Pluribus Unum* (EPU) is free to teachers to supplement their courses and individual students who want to learn CS independently. EPU will use analytics to understand how well students are learning computer science using EPU and how to improve both the questions and the overall system. The protection of student, teacher, and school privacy will be of utmost importance. Volunteer teachers and organizations will author the questions for EPU except for those of the generic reference culture and a few exemplars.

## Scenarios

### Student Scenario

CC is a 15-year-old Hispanic girl at ZN High School in north Seattle. Although she did not choose to take the elective, CC is taking Mr. TM’s Introduction to Comp Sci class due to scheduling issues.

At first, CC is somewhat discouraged that one of the first assignments is a “pre-test” to measure her current knowledge of foundational computer science. However, she is pleasantly surprised to learn that she can take a “Hispanic/Latinx Teenage Girl” version of the pre-test with questions relevant to her life that give her instant feedback on the correct answer to each question. After completing the “pre-test” and seeing her scores, CC receives links to resources created explicitly for “Hispanic/Latinx Teenage Girl” to learn foundational computer science. These resources feature videos with young Hispanic/Latinx teachers and computer industry professionals and links to organizations that will support her journey in computer science. After taking the pre-test and previewing some of the additional resources, CC has a better idea of class content and how it relates to her life now and in the future.

Throughout the semester-long course, CC's teacher assigns her class to take some practice sessions at the same website to review/preview course concepts and measure progress. In these practice sessions, CC chooses to see flashcard questions from cultures such as "American Girl," "Biology," "Music," and "Soccer Fan." She can even get some questions in Spanish. She is encouraged that her performance in these sessions continues to improve through what she learned in class and previous practice sessions. Through the practice sessions, CC also gains a deeper understanding of CS and how CS is everywhere. And CC feels pride when her score on the "Hispanic/Latinx Teenage Girl" session at the end of the semester is 48% higher than the pre-test.

At a holiday gathering with her extended family, CC meets her cousin JM, a senior at a high school that does not have a computer science course. JM plans to go to college the next school year and worries that she needs a better understanding of computer science before attending college. CC introduces JM to the website that CC used for her Introduction to Comp Sci class. JM signs up on the website on her own, decides to take the "Biology" pre-test, and uses the link to the resources she receives to start her exploration of computer science.

## Teacher Scenario

Mr. TM is a 57-year-old Caucasian male who switched from an IT career to teaching 20 years ago and is CC's teacher in the Intro to Comp Sci class at ZN High School. Priding itself on its multi-cultural student body, ZN HS has 30% FRL students with about 54% Caucasian, 12% Black, 12% Asian, 12% Hispanic/Latinx, 4% Native American/Eskimo/Pacific Islander, 6% Other. About 6% of students are ELL; 6% are IEP/504. There are 30 students in Mr. TM's 6th-period Intro to Computer Science class with a 30/70 female/male split. Students are from all four grades but are strongly skewed toward freshman/sophomores. While there are relatively more Caucasian/Asian students in Mr. TM's more advanced computer science classes (e.g., AP CS A), there are relatively more minorities and ELL/IEP/504 students in Intro to Comp Sci. As there are no pre-requisites for any of his CS classes, students have a wide range of previous experience and abilities coming into Intro to Comp Sci.

Mr. TM greatly appreciates the *E Pluribus Unum* (EPU) website. EPU provides him with insight into how his students are progressing throughout his Exploring CS course in a relatively fun and non-threatening atmosphere and preview/review content simultaneously. Mr. TM also appreciates how EPU provides each student with computer science content that is the most relevant and exciting to them. At his age, it is enough of a challenge for Mr. TM to make computer science enjoyable to teenagers in general. But it is almost impossible to provide the individualized curriculum he feels each student needs to get the most out of Intro to Comp Sci and be inspired to take other CS classes. EPU is a start in that direction.

Mr. TM also appreciates how he can provide feedback on the questions and resources provided through EPU. He has also heard from the EPU editorial board that a group is starting to develop questions and resources for a new "Personal Finance and Careers for Teens" culture and plans to join it.

## Rationale

*E Pluribus Unum* (EPU) multi-cultural computer science flashcard system provides at least a partial solution to a wide variety of issues:

- Educators need to make computer science more appealing to students from various backgrounds and have them see themselves in computer science. Even within a single classroom, students may have multiple backgrounds and interests that would be difficult to address in a single curriculum.
- Questions from different cultures and different fields of study often have the same solution in code and teach the same underlying CS principles. Students can better learn the computer science concept of abstraction by seeing the same technical solution solve questions from various cultures/contexts. And by seeing questions from a wide variety of cultures and fields of discipline, students can better appreciate that CS is everywhere, for everyone, and that the essence of good computer science is to find the common patterns in problems from all walks of life and provide solutions for them.
- Computer science requires students to choose from several strategies (e.g., variables, loops, conditionals, lists, objects, decompositions) and determine how to use them together in a solution. This ability is different from learning how to use these various strategies in isolation in a unit. Much like actual programming, interleaved practice and feedback on relevant CS concepts require students to preview, review, and choose various strategies and apply them. The interleaved practice from EPU flashcard learning sessions spread throughout a course can help students develop a long-term, lasting understanding of foundational CS concepts.
- Both CS teachers and students want a low-stakes way to aid the teaching and learning of CS and measure progress and growth from the beginning to the end of class. Teachers can utilize EPU regardless of their curriculum for foundational computer science.

## EPU Cultures, Questions, and Resources

EPU cultures are a broad concept that links a complete series of questions and educational computer science resources around a common theme or group of people with common interests. They are limited only by the creativity and passion of contributing teachers and organizations. Some examples of possible EPU cultures: teenage girls, Sports, Southern, West Coast, inner-city, rural, Hispanic/Latinx, Black, Native American, Spanish, Korean, smartphone fanatics, vision impaired, Hawaii, dad jokes, “fill-in-the-blank” fandom, LGBTQ, military, gamers, music, science/biology, business/economics, environment, social justice.

Teachers and organizations can create their own EPU culture by adding/maintaining a complete set of questions and answers for the EPU culture they agree to manage. Teachers can provide even more variety and learning potential by creating multiple questions for their EDU culture for each question type. At present, how teachers will author questions is TBD. A wiki of some sort is a likely solution.

Teachers/organizations authoring cultures are also encouraged to find additional resources that teach foundational computer science concepts in a way that appeals to students interested in that culture. Depending on their performance, these resources will be shared with students at the end of their learning sessions. Culture authors may also provide links to organizations and opportunities for students interested in their culture that are willing to help students on their path in computer science. Any content linked as a recommendation from EPU must meet specific editorial guidelines (free, no login required, age-appropriate, etc.).

## Learning Sessions and Question Types

A single online EPU learning session consists of 10-50 multiple choice questions – one of each question type in random order – taken either from a single EPU culture or randomly from several EPU cultures. After students answer each question, they are shown the correct answer with a quick explanation. After students have completed all questions, they can view

- Their overall score in this session
- How they performed in various areas
- How they scored compared to previous attempts
- Links to educational content for the areas they need help

The links to additional content will be from the students' chosen EDU culture if this content is available and from the generic reference EDU culture.

Learning sessions can be saved and restarted – meaning that students can save a session and return to it later. Whether an entire learning session or individual questions will have time limits is TBD.

Each EDU culture must provide at least one question for each question type. At present, I expect there will be 50 question types, each covering a different underlying code or concept from a foundational computer science course. Maps to the appropriate CSTA standard will be provided for each question type.

While the exact list of question types is TBD, some ideas follow:

- Abstraction
- Decomposition
- Pattern Recognition
- Password Strength
- Data Encoding
- Variables
- Variable Types
- Using Functions
- Conditionals
- Iteration

- Data Transmission
- Data Storage
- Using Lists
- Understanding Objects

Great care (and peer review) is necessary so that the questions in the generic reference culture are appropriate and cover the desired scope. The questions in the generic reference culture must make it relatively easy for EDU culture question authors to create appealing versions covering the same code/concept for their EDU culture. A question like "Which of the following is the best definition of the term 'variable'?" would not be good; a question like "In Interesting scenario A, which of the following would be an appropriate variable name?" would be better.

The list of question types presented to a student in an EPU training session will depend on the number of questions and the level of difficulty chosen by the student for that session.

## Learning Programs

A typical learning program will consist of 5 "official" learning sessions spread out over four months – at the beginning of the program and the end of each of the next four months. The first and the last "official" learning sessions will be in the EPU culture of the student's choice, and the other three "official" learning sessions will contain questions from various EPU cultures. The difficulty level and the number of questions for each of these 5 "official" learning sessions will be the same as that chosen for the initial session. In addition, students can also take as many "unofficial" training sessions as they want, varying the difficulty level, number of questions, and EPU culture for each training session.

Students deciding to take an EPU learning program independently of a school course will have the EPU cultures they can specify, the difficulty level, the number of questions, and the timing of their various official learning sessions scoped by EPU editors.

Students taking an EPU learning program as part of a school course will have the EPU cultures they can specify, the difficulty level, the number of questions, and the timing of their official learning sessions determined by their teacher.

## Other FAQ

### 1. Why focus on questions for high school foundational computer science?

At present (Mar 2022), the primary focus of US K12 CS education advocacy efforts is a foundational computer science course with at least 20 hours of programming accessible in every high school (and hence to every high school student) in America. According to the [2021 State of Computer Science Education](#) report, only 51.7% of high schools in America have a foundational computer science course.

High school foundational computer science focuses more on computer science concepts, computational thinking, the intersection between computer science and society, and learning to read code than programming and other software development skills. This focus allows for the easier development of appealing and culturally relevant multiple-choice questions than a focus on software development skills.

While high school students are the primary audience for EPU, middle school students can also benefit if teachers choose appropriate EPU cultures and learning session difficulty levels for their students. College students may also find EPU a solid introduction to computer science concepts, particularly if they did not have the opportunity to take a computer science class in high school.

## **2. Will EPU training sessions (including the final session) affect student grades?**

Teachers have discretion as to whether and how to include EPU scores in students' course grades. I suggest that teachers grade each official learning session as a mid-sized assignment that encourages students' best effort, improvement, and completion by a given date.

Making EPU a high-stakes assignment or an exam will likely be counter-productive. Students can take as many unofficial training sessions as they want. There will be no attempt by EPU designers to prevent cheating or answers from being published. The randomization of EPU cultures, question types, and answer orders within each flashcard learning session will likely make any attempt to find the correct answer at least as time-consuming – and a learning experience in itself - as just trying to do one's best. And having students help each other with EPU questions is not bad either.

## **3. What hardware/software will an EPU learning session require?**

EPU learning sessions will be delivered through a browser and will work best with a tablet, notebook, or desktop with solid Internet access. While a student could take an EPU learning session on a smartphone, some questions from many EPU cultures may be clumsy to take on a smartphone. "Smartphone" EPU cultures can provide questions for students that "must" take learning sessions on their phones.

There are no plans to create a tablet/mobile app or a desktop application for EPU. Students will not be able to participate in an EPU learning session without an active Internet connection.

Teacher functionality will have similar requirements.

## **4. What about other languages? What about students with disabilities?**

Questions in another language will be just another culture in EPU. If a teacher/organization decides to translate the questions in the generic reference language into another language (e.g., Spanish), all students will have the opportunity to try to answer computer science questions in

that language. The questions for the translated language may also be localized beyond a simple translation, and there may also be EPU cultures in another language without an English counterpart. While the language of the questions may change, the core UI for EPU beyond the actual questions will remain in English.

The core EPU UI and the questions in the generic reference EDU culture will comply with all accessibility guidelines. However, it is unlikely that all questions in all EPU cultures will be fully compliant and not further disadvantage students with disabilities. Teachers may want to create EPU cultures optimized for students with disabilities. EPU “content editors” will also work on “accessibility” guidelines for EPU culture authors and consider ways of flagging EPU cultures and questions that are accessibility ready and those that are not.

## **5. What about security and privacy?**

Present thoughts on security are:

- Students must register with a verified e-mail, a unique username, and a reasonably complex password. If students are using a school e-mail that cannot receive mail from EPU, then the teacher must validate students' e-mail and respond to password reset requests. No plans to support single sign-on. Additional protections for students under 13 will be implemented (clarification necessary)
- Teachers must register with a verified e-mail, a unique username, and a reasonably complex password. Additional verification of teachers' good standing will also be required.

EPU will take great care to protect student, teacher, and school privacy. However, EPU will collect detailed data on student performance in learning sessions to understand how much students and which students are learning. Present thoughts on privacy are:

- Free. No ads.
- No cookies except what is necessary to maintain user-session information.
- Editorial control over the links presented to students in questions, explanations, and additional content. (clarify?)
- Careful consideration of demographic questions asked of students and teachers during registration.
- Only teachers can see non-anonymized student results and will not see student e-mail
- Hiding individual school, teacher, and student PII from use for all data analysis purposes. Great care will also be taken to aggregate data wherever anonymized data could be used to identify an individual school, teacher, or student.

## **6. What programming language or pseudo-code will EPU use for questions/answers?**

TBD. Most likely a strange mix of custom pseudo-code and block-based programming. Interested in hearing various opinions on this matter.

One exciting possibility here is to use the Quorum programming language (<http://quorumlanguage.com/>) because of its importance in the accessibility community, its “neutrality” in relation to other popular programming languages, and as these questions are not to ask students to write code but to be able to understand basic coding constructs.

**7. How will code be developed?**

TBD. All code for EPU website functionality will be freely available in the public domain. While EPU implements a specialized content model, the code required for the EPU website should be straightforward for a developer experienced in the relevant technologies.

## History

4/1/22	Initial Draft completed and published on Cranidores.org and CSTA forums.
4/4/22	Added section on scenarios, added more info on culture-specific resources, and on potentially using the Quorum programming language for code/pseudo-code examples.

