Integrating CS into Middle School and High School Curriculum

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Challenges and Motivation

Indeed.com alone claims that California alone has about 35000 entry level Computer Science (CS) jobs in California when a search is done on that website. Estimates of total entry-level CS jobs in California vary from about 50000 to 100000 centering around 75000. And the number of Computer Science graduates in the entire country including *all* 50 states is about 33000.

Clearly our educational system cannot produce enough graduates to meet the demand. One way to improve the local supply of Computer Science graduates would be to get more middle school and high school students interested in CS. But things are easier said than done. Almost all school districts face serious issues in integrating Computer Science into the classrooms. The main problems are lack of funding, lack of teachers, and if time slots are lost for other subjects teachers cannot complete the common curriculum.

There is a wider problem as well. Until recent times most people picked one industry and stayed in that life-long and a smaller section chose to change carreers once or twice: imagine changing careers continually – sometimes incrementally and sometimes quite drastically. Welcome to the Age of Information. There is a saying that is commonly attributed to Alfin Toffler "Illiterate of 21st century is not the one who cannot read or write but the one who cannot learn, relearn and unlearn." With the rapid changes in technology that saying verily stares us in our eyes: Students do need a mode of learning in which they can learn to be continually learning and relearning. And Computer Science does help each every one of us on the relearning goals: some of the key algorithms would **include indexing, tagging, storing, and sorting of what we have been learning**.

To get *all* students some elements of a relearning process it is imperative that we introduce them to elements of Computer Science without a massive disruption in the students schedule or teachers schedule especially since both groups are already stretched. And the School Districts do not have enough resources. Some of the better off parents may be able to help their children with the emerging learning paradigms and the poorer ones are left father behind, which in turn complicates the teacher's workload since they need to teach a set of students with wide variations in learning skills.

The goal here is to provide a simpler, manageable solution to get more students interested in CS especially the underprivileged.

A simpler solution

Many approaches are possible to introduce CS into Middle and High Schools. Some schools attempt to integrate CS through a separate class on introducing programming through a separate class on game-design. That approach is resource heavy: students need to budget time for an additional *period* or sacrifice an elective in the liberal arts (like skip Band/Leadership classes etc). In addition, another downside is that the students and teachers need to learn a heavy load of application-dependent skills – how best to use that particular software which would become obsolete in a few years.

A smarter strategy would be to integrate Computer Science into the regular curriculum that is *free* of dependency on tailored software applications. For eg. In Language Studies the teachers can be empowered to teach the similarities and differences between the grammars of Natural Languages and Computer Languages. And PE teachers can be empowered to incorporate Computer Science Games in their fields. Yes, Computer Science can be introduced in every domain and that too *without learning new software applications*. And I will next illustrate in more detail how Computer Science can be integrated into different subjects.

Integrating Computer Science into Math Curriculum

Math provides the natural entry point for teaching Computer Science in the classroom. There, however, is a big pitfall that one needs to avoid. Computer Languages come and go. For example BASIC was popular up to the 1980s until C language displaced it. Since the mid-1990s Object Oriented Programming Languages like C++ and Java dominated the scene and these days the most popular language is Python these days. When creating material to empower Math teachers to integrate Computer Science into math, we can use a combination of flowcharts and pseudo code. Both tools are useful tools for a wide variety of Engineers in typical Software Companies like say Microsoft or Synopsys.

Some examples

Loops and functions can easily be introduced in almost all topics in Math. In seventh-grade, the typical Math teacher can be empowered to teach loops when teaching (a) factorials, (b) geometric and arithmetic series. Pseudocode for the function to compute Factorial:

Initialize_index to N and result to one

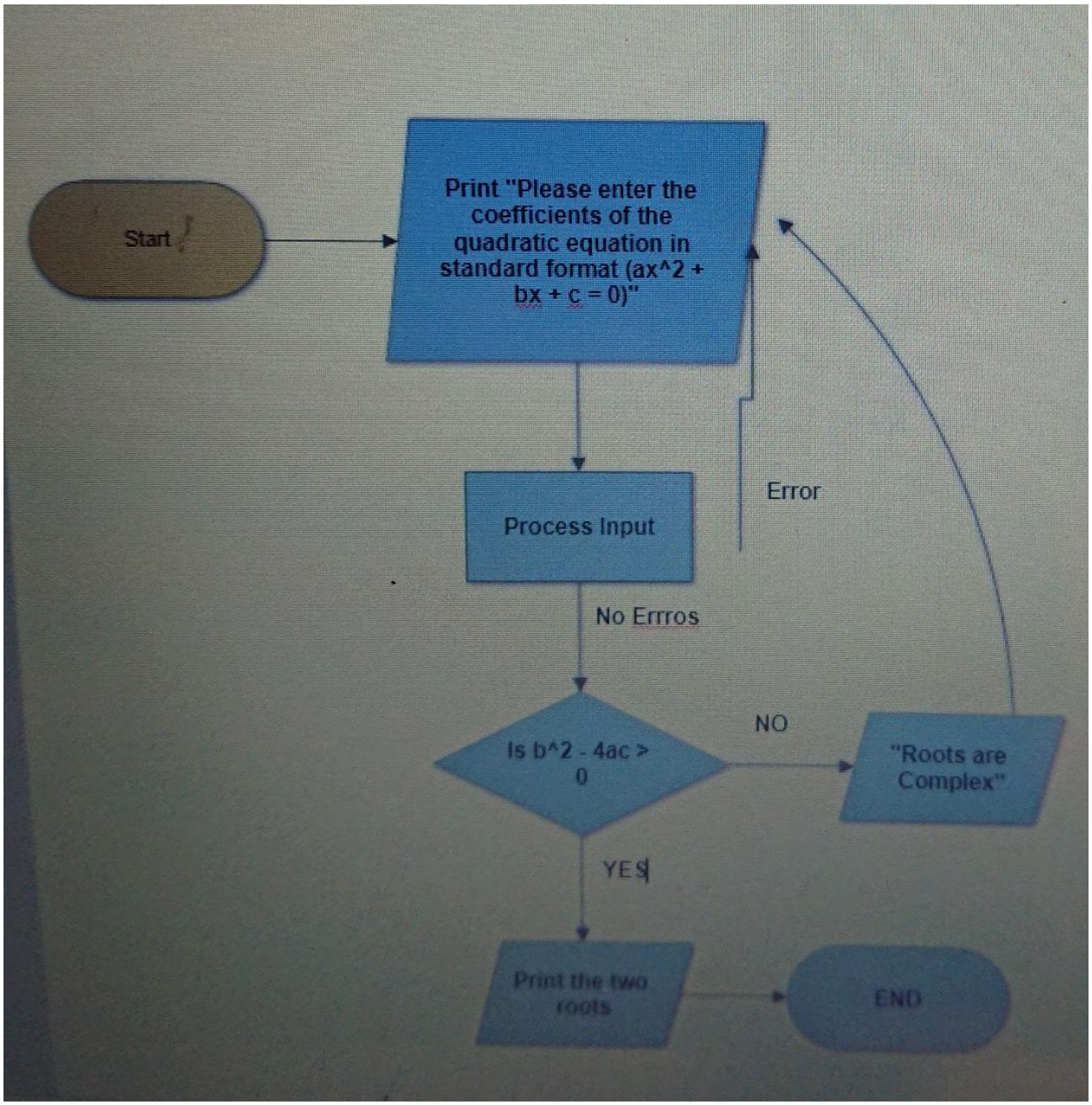
Begin Loop in index from N to 1

*Result *= index*

End Loop

Send Result

In eighth-grade, we can integrate flowcharts (and pseudocode) for computing the roots of a quadratic equation.



Summary

Integrating elements of Computer Science (CS) into regularly scheduled classes appears to be a good entry point instead of adding a separate class which needs additional resources and scheduling. We can together come up with detailed lesson plans for teachers to add CS to their curriculums in Language arts, Math, Science and PE. A good starting point is creating methodology for integrating CS into Math Curriculum. We can then test its effectivity before ramping it up for other subjects.