Pathway from Learning Multimedia Software to Computer Science Education

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Abstract – *In this paper, we propose a pathway to encourage high school students pursuing computer science study with 3 steps – from application users to basic programmers. Multimedia software and MS-Excel can be adopted to help high school students to work on video, animation, data analysis for homework or extracurricular projects, which could reduce frustration that one would experience when jumping directly into learning computer programming language. This would consequently increase opportunities in understanding software design. High school computer science curriculum should be designed to encourage more students to smoothly transition from applying the tools to their science and non-science subjects into studying computer science or technology related fields. In addition, statistics show that the rate of switching majors is very high in college STEM programs. Therefore, we also offer some suggestions which would help high school students better understand whether a future in computer science is something they want to pursue.*

Keywords: STEM education, computer science, High school curriculum, animation

1 Introduction

Computer and Information Technology related jobs [9] include many different kinds of positions – researcher scientists, programmers, network architects, support specialists, system analysts, database administrator, network and system administrator, developers for software and web. In software industry, there are some typical functional groups and roles, such as System Engineer for requirements, developer for coding and tester for testing. In colleges, in addition to the traditional computer science, there are more and more schools separated the computer related fields into different concentrations or tracks - Graphic Design, Game and Interactive Media Design, Human Interaction, Information Technology, Information Science. Many of these computer related jobs and studies do not require strong programming skills. Therefore, it is very important to firstly give an overview of computer fields and interesting hands-on tasks to the students in secondary school to trigger their interests in learning information technology and computers.

Projects and competitions can be an excellent way to encourage students in middle and high schools to engage with information technology; because there are clear objectives for students to achieve. There are many popular competitions for students in middle school and high school to compete in the United States. National History Day (NHD) [1] and Technology Student Association (TSA) [2] are two well-known extracurricular competitions in the United States. In these competitions, students advance from regional, state to national levels. Of NHD's four categories, two of them – websites and documentaries – require students to utilize computers and technology to create their projects. This encourages students to explore the usefulness of computers to accomplishing tasks. TSA's competitions focus more on science and technology. For instance, SciVis, Open Source Software, and Robotics competitions strongly require students to utilize computer technology. For NHD competition, students only use the software and do not need to code in detail. On the contrary, students who participate in TSA may need stronger knowledge and interests in technology and computer science.

In addition to academic competitions, there are also many non-academic opportunities in which students can utilize technology to work on projects, such as the Girl Scout Gold Award project [3], which is the highest honor in Girl Scouts, and the Boy Scout Eagle project [4], which is the requirement for the highest Eagle rank. Both projects, which students often compete during high school, require significant and long-term contributions to the community. Many Eagle Scouts work on physical projects such as constructions, and many Girl Scout Gold Award projects are done in community service. With the advent of modern technology, students are also allowed to have their projects mainly based on computers or other technologies as well. A study [5] showed that the girls of middle school students could be interested in studying computer science, if they were able to exposure to interesting computer games. Here, we will discuss how IT projects can help high school

students understand the technology and become interested in studying computer science related fields in college.

Therefore, the first step is to let the beginners experience their interesting software.

2 Software to Create Educational Multimedia

Computer fields become very diverse in past decades and it is helpful for students to explorer the fields from software applications, not jumpstart from programming. This way, it will give students as the end-user role to understand in high-level about software features, user interfaces, and computer-human interaction.

As mobile devices gain popularity, more and more educational multimedia materials are being produced. That also encourages more and more students use Window Media, Apple iMove, and Adobe Premiere to make multimedia projects. Students can utilize the software to design theme, add texts, and edit video and audio clips to make multimedia production. Students can present their creations for class work and competitions, and even share them through Youtube, Facebook, and other social media.

Working with these software triggers students' interests in pursuing digital media design, movie-making, or software design fields in colleges. These majors could be under College of Design, College of Arts & Sciences, or College of Engineering. The curricula could differ very much between these colleges, so it is very important for students to understand the differences in education objectives. Here, we use the software Autodesk Maya and Adobe Premiere as examples to discuss how the software could impact students who are learning information technology.

Figure 1 3D animation

Maya is a very popular animation software used in industry but is free for academic use. In order to make competitive projects, students have the option to make 3D animations as shown in Figure 1. This requires them to learn and understand how to realistically design, move, and construct 3D-models, realistically light the environment, and

understand some basic computer graphics such as transformation – translation and rotation to move objects smoothly. Students can combine the animated objects with sound and text to make an animated movie and save the projects into AVI, MP4, or MOV formats in High Definition (HD) resolution.
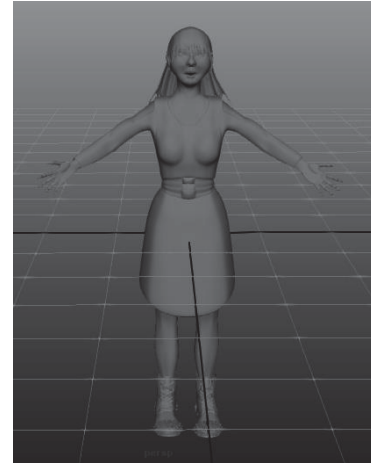
Figure 2 3D Modeling

The 3D-modeling process, shown in Figure 2, will allow students to connect to mathematical concepts better, especially in coordination. This will lead students to do better in algebra. Algebra is the core curriculum of mathematics in middle schools and the foundation for all later mathematics. The computer graphics transformations will give students strong training in geometry concepts while they move the objects around in their projects. Geometry is normally taught in 8th or 9th grade, which is an important stage for students to explore and decide if they want to pursue the STEM areas. Therefore, since Maya is free to academia, schools could offer classes that use the software and encourage students to work on projects using the software.

Adobe Premiere and iMove are two popular software for making videos. They allow users to crop, edit and merge photos, videos, audio, and text. Although it doesn't require much mathematics, the software has many features for students to work and learn visual effects so it gives them experience with Human Computer Interaction (HCI) and Graphic User Interface (GUI) software design. These two areas are getting more attention in computer science education, because it is very important to have well-designed interfaces on mobile devices. Therefore, a new emerging field of art and software design has been established in colleges over the past few decades. Students who study in art colleges need to learn basic software design, and students who study computer science are encouraged to take art and human behavior related courses to design better software interfaces. Many computer languages have Integrated Development Environment (IDE) such as Eclipse

and it provides friendly environment and better way to write programs. It does help a lot to reduce frustration of learning a new language for a beginner in computer science.

3 Interests vs. Major in Computer Science

Statistics show that about 69% of bachelor's degree candidates in science, technology, engineering and mathematics leave the field before completing a college degree [6]. While students could be interested in software design and digital media design fields, they might be not sure which areas to pursue and confused by the majors during the college applications. US high schools currently offer core curriculum in mathematics, sciences (biology, chemistry, and physics), humanities, and English. Although some comprehensive high schools could offer elective courses in calculus and computer related course, many schools don't offer computer programming courses such as Advanced Placement (AP) computer science. New Jersey state Assembly has passed the bill 2597 [7]: Provides that beginning with the 2014-2015 grade nine class, Advanced Placement computer science course may satisfy a part of either the mathematics or science credits required for high school graduation. This will help students in high schools truly understand what computer science is.

The web 2.0 provides a lot of static online information for computer science education. Teachers and students are able to access free documentation on software or hardware vendors such Oracle, W3School, etc. There are many free websites for people to receive answers about questions they have such as youtube.com, stackoverflow.com, etc. Online learning becomes playing important roles in computer science education because classroom and books are not the only resources for students to get knowledge and answers on all subjects. If schools cannot offer computer programming courses, it is important for the school to advise students to utilize online resource for self-studying to explore computer science.

A course with some basic programming and discrete mathematics knowledge should be included as an elective course for juniors and seniors who want to pursue computer science. The attrition rate was highest for bachelor's degree candidates who declared a major in computer/information sciences [6]. Because there is a gap in the curriculum between high school and college STEM programs, many students have difficulty adjusting the way they study and smoothly transitioning into freshman year. Hence, they might decide that computer science is not for them and they may change to another major that has a more liberal atmosphere that is similar to that in high school. Students might be interested in software development, HCI and GUI design, but these areas are totally different from high school mathematics and science courses they have taken, and most

of college computer science courses required to take advanced courses which freshman students might not be good at. This may be a factor for the numerous high school students who have difficulty transitioning during the dramatic changes in their first year in colleges.

In short-term, if high schools don't have the resources to teach computer related topics, they should allow students to take courses at local colleges or online to make sure students truly understand what computer science and engineering are. High schools should also invite computer science and engineering professionals to give seminars for juniors and seniors. In long-term, the education department should design a course in career development for the high school curriculum to let students know the college study, jobs and career for common colleges and fields.

Once the secondary school students are familiar software applications, they could be ready to do some basic programming. Here, we suggest schools to adopt an introductory course that been taught in many community colleges or for non-computer science major students before the students learn any programming languages.

# 4 Computer Science Curriculum for High School

Companies are promoting computer programming to become part of the high school curriculum. However, students could be permanently lost interest if their first computer course is too tough to learn or too theoretical to apply into the real world. It is necessary to have an essential and practical computer science course(s) for high schools that will make learning computer science a more interesting subject. Current US AP-Computer Science curriculum requires a technology teacher capable of teaching computer Java programming, so only comprehensive high schools are able offer full time positions to these teachers. The course is fast-paced so it becomes a little challenging and thus deters many students from taking the course. Data [8] shows that only around 21,139 students in 2011 took AP-Computer Science exam. It is around 0.5% of 4 million high school senior students in the US. If we want to promote computer science in high schools, a better curriculum is needed.

In this section, we will discuss three types of Introduction to Computer Science course: Multimedia and Animation, Data Analysis and Marco Programming using Spreadsheet, and programming in an Integrated Development Environment (IDE). The three types of courses fit to different curriculum design.

4.1 Multimedia and Animation

The computer science curriculum in high school can start from utilizing software to create visual effects such as using PowerPoint, Photoshop, iMovie, Adobe-Premiere and data modeling using Maya animation in 9th and 10th grades.

These topics will help students to make multimedia projects and also learn software functions. Shown in Figure 3 is a student animation project that helps others to understand human nerve system.
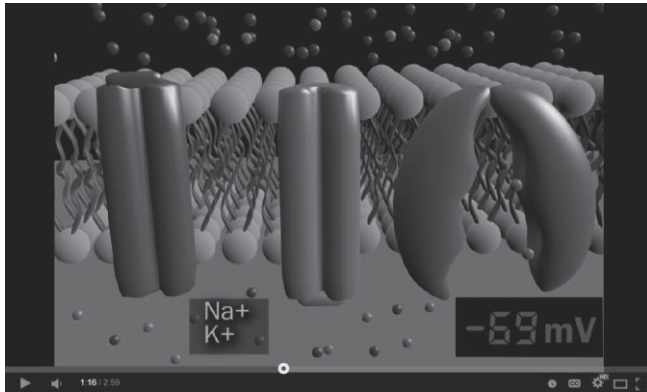
Figure 3 A student animation project to help understand human nerve system

In this type of course, students are introduced with various software application that are easy to use and the result can be observed immediately. There are no programming skill required. As students can show off their works and gain confidence, motivation to continue on to other computer science courses will be greatly improved.

4.2 Data Analysis and Marco Programming using Spreadsheet

A more advanced course, comparing with the multimedia in previous section, is to teach data analysis and marco programming concepts. Data analysis and marco programming concepts using MS-Excel, OpenOffice-Calc, Google-Sheets or other software can be taught between 10th and 11th grades.

To simplify the discussions, we will use Microsoft Office to discuss because it is popular among students to write reports in MS-Word, presentations in MS-Power Point, and spreadsheet work in MS-Excel. Teachers and students can utilize the MS-Excel functions to learn basic programming concepts listed below:

- *Variables*: In MS-Excel, cell ID, such as A1 (1st row at column A), B2 (2nd row at column B) can be considered as variables in programming languages.
- *Data type*: integer, double, string used by cell IDs.
- *Assignments*: if A2=1, B2=2, at cell C3, type *=A1+B1*, it will show 3 in C3.
- *String concatenate*: if A2=1, B2=2, at cell C3, type *=CONCATENATE(A2,B2)* , it will show 12 in C3.
- *Boolean – TRUE, FALSE, NOT:* if A2=1, B2=2, at cell C3, type *=A2=B2*, C3 will show FALSE. If we type =NOT(C3) at cell D3, it will show TRUE at D3.

- *Logic operator*: if A3=FALSE, B3=TRUE, at cell C3 type *=OR(A4,B4),* it will show TRUE at C3.
- *IF statement*: if A1=1, B1=2, at C3 type *=IF(A1=B1,1,0),* it will show 0 at C3.
- *Complex IF statement*: if A1=1, B1=2, C1="a", at C3 type *=IF(OR(A1=B1,C1="a"),T,F),* it will show T
- *Aggregate functions – AVG, MAX, MIN, STDEV, COUNT, SUM, etc* : if A1=1, B1=2, C1=3, at C3 type *=MAX(A1:C1)* , it will show 3.
- *Substitute*: if A1="abcd", at C3 type, =SUBSTITUTE(A1,"ab","AB"), it will show ABcd at C3.

Figure 4 is an example using MS-Excel if-else statements to determine students' grades of a class.
=IF(E2>=90,"A",IF(E2>=80,"B",IF(E2>=70,"C",IF(E2>=60,"D","F"))))
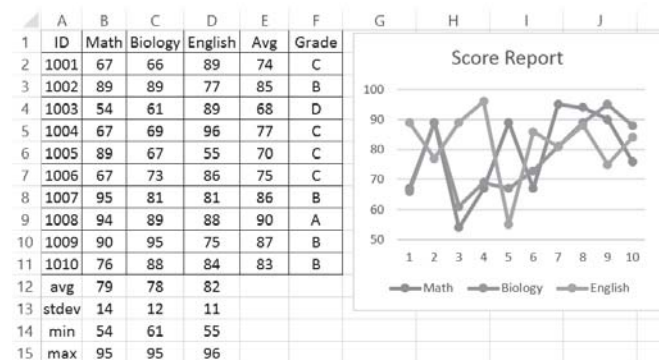
Figure 4 Data analysis using Excel cell programming

In order to give students more opportunities to explore basic computer science, teachers could ask students to utilize MS-Excel spreadsheet to do science or math homework, or even analyze their home electric and gas bills using the above basic computer programing components to analyze the data, display them in charts, and submit or present the final reports with charts.

MS-Excel also provides macro for users to write programs in VB to access worksheet and data cells. There are many online Excel macro tutoring [11] and it is very easy for student and non-computer science teachers to learn Excel macro and VB programming. Figure 5 shows the VB codes finding students who have grade >=90 when users click the button on worksheet as shown on Figure 6. Students can use Excel functions and macro to analyze data for school projects and competitions.

```
Private Sub CommandButton1_Click()
    Dim n As Integer
    Dim cell1, cell2 As String
    For n = 2 To 10
        cell1 = "E" + CStr(n)
        cell2 = "A" + CStr(n)
        If Range(cell1).Value >= 90 Then
            MsgBox ("ID" + Range(cell2).Value + " has grade A")
        End If
    Next n
End Sub
```

Figure 5 MS-Excel macro to find students who has grade A

	A	B	C	D	E	F	G	H	I
1	ID	Math	Biology	English	Avg	Grade			
2	1001	67	66	89	74	C			
3	1002	89	89	77	85	B			
4	1003	54	61	89	68	D			
5	1004	67	69	96	77	C			
6	1005	89	67	55	70	C			
7	1006	67	73	86	75	C			
8	1007	95	81	81	86	B			
9	1008	94	89	88	90	A			
10	1009	90	95	75	87	B			
11	1010	76	88	84	83	B			
12									
13	Find who has grade A								

Microsoft Excel

ID1008 has grade A

OK

Figure 6 MS-Excel macro display a message box when the program find a student who has grade >=90 after the "Find who has grade A" button is clicked

5   Programming in an IDE

Once students become more interested in learning advanced computer knowledge, students can take a dedicated programming course in 11th and 12th grades. This programming course may teach Java, C++ language or any programming language and programming skills using integrated development environment such as Eclipse. This course can also utilize even simpler IDE, such as Alice, that does not incur any complexity from production code structure.

Alice, shown in Figure 7, is designed solely to teach programming theory without the complex semantics of production languages such as C++. Users can place objects from Alice's gallery into the virtual world that they have imagined, and then they can program by dragging and dropping tiles that represent logical structures. Additionally, the user can manipulate Alice's camera and lighting to make further enhancements. Alice can be used for 3D user interfaces.

A controlled study at Ithaca College and Saint Joseph's University looking at students with no prior programming experience taking their first computer science course, the average grade rose from C to B, and retention rose from 47% to 88% [10].
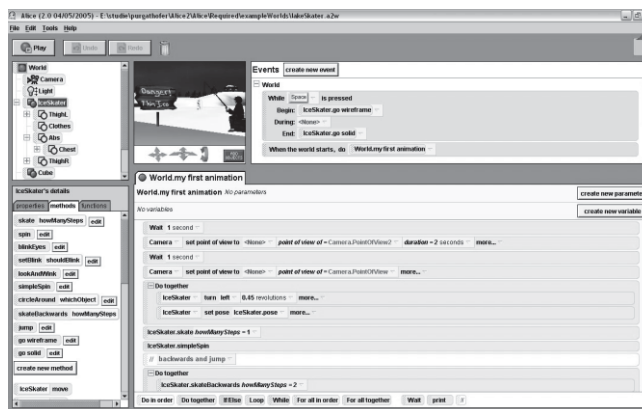

Figure 7 Alice IDE

6   Conclusions

In this paper, we propose a conceptual pathway for students in secondary schools to guide their learning in technology and help them to pursue in computer science fields later. Since today's mobile devices are actually computers and can perform most of he computing tasks, there are more software applications (Apps) developed on the mobile devices than on personal computers. The job market in computer and information technology today has a very strong demand for more skilled people. In the United States, the field is predicted to be 1 million people short by 2020 [12]. It is critical for US to encourage students in middle school and high school to pursue career in the fields of computer science and it's related.

However, it is not necessary to train students just to become software developers, as many computer related jobs do not require programming skills. Those jobs could require students to have good sense of designing user interface, analyzing the data with tools, testing the features, or utilizing information and managing the technology. Therefore, it is more important to keep students interesting in information technology, than learning how to program. The keys to reach this goal are first to encourage students to work on projects using multimedia software and to design a better curriculum utilizing the software, especially in secondary schools. Once students become interested in utilizing computers, there will be more motivation for them to take AP-Computer Science during their high school year, to study computer related studies in university and pursue their career in computer filed later in life.

7   References

[1]   National History Day (NHD) http://www.nhd.org/

[2]   Technology Student Association (TSA) http://www.tsaweb.org/

[3] Girl Scout Gold Award Project, www.girlscouts.org/program/highest_awards/gold_awar d.asp

[4] Boy Scout Eagle Project, http://www.scouting.org/scoutsource/boyscouts/advance mentandawards/eagleworkbookprocedures.aspx

[5] Stewart-Gardiner, C., Carmichael, G., Latham, J., Lozano, N., Greene, J., "*Influencing Middle School Girls to Study Computer Science Through Educational Computer Games*", Journal of Computing Sciences in Colleges, Vol 28, June 2013

[6] Megan Rogers, "STEM-ming the Tide" *Inside Higher ED,* November 27, 2013. https://www.insidehighered.com/news/2013/11/27/study -tracks-attrition-rates-stem-majors

[7] New Jersey Assembly Bill 2597, http://legiscan.com/NJ/bill/A2597/2014

[8] "CS Education Statistics" *Exploring Computer Science*. http://www.exploringcs.org/resources/cs-statistics

[9] "Occupational Outlook Handbook - Computer and Information Technology Occupations", http://www.bls.gov/ooh/computer-and-information-technology/home.htm

[10] M. Moskal, D. Lurie, and S. Cooper, Evaluating the Effectiveness of a New Instructional Approach.

[11] http://www.excel-easy.com/vba/create-a-macro.html#developer-tab

[12] Allie Bidwell, "Tech Companies Work to Combat Computer Science Education Gap", US News, Dec. 27, 2013 http://www.usnews.com/news/articles/2013/12/27/tech-companies-work-to-combat-computer-science-education-gap