

**Instructional Design Document: How Computers Work: Culturally Relevant Instruction to Engage Women, African-American and Latino Students in Technology**Andrea Boykin
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 This document provides design specifications for the development of the How Computers Work digital training module. This module is designed to provide supplemental training material for an informal learning course about computer parts and how they work. This informal learning course targets middle school-aged students enrolled in various afterschool classes hosted by Uplift, Inc. and is a gateway course to many others offered by the organization (i.e. game design, robotics, app development, animation, etc.). Various segments of the module are also geared towards raising awareness and inspiring engagement in STEM (science, technology, engineering, and mathematics) by focusing on computer scientists of color and their contributions to the field. Uplift, Inc. is a nonprofit organization in Washington, DC that provides annual formal and informal educational opportunities in (science, technology, engineering, and mathematics) STEM+Art.

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**Background**

**Client:** Uplift, Inc.
 Uplift, Inc. is a nonprofit organization in Washington, DC that guides PreK-12 grade students through innovative out-of-school educational experiences in Science, Technology, Engineering, and Math (STEM) using culturally relevant, project-, and inquiry-based pedagogy. The organization has a particular interest in engaging African-American and Latino students in Science, Technology, Engineering, and Mathematics

**Training Need**

Technology is prevalent in the world of today’s youth, and is predicted to be pervasive in the world young people of today will work and engage in as adults (Committee on Prospering in the Global Economy of the 21st Century, 2007; CSTA, 2011; Modi, Schoenberg, & Salmond, 2012; National Science Board, 2010; PCAST, 2010). For this reason, there is growing momentum to introduce youth to necessary computational thinking skills needed to help ensure their (and the country’s) success in the global economy, especially as it relates to STEM (Committee on Prospering in the Global Economy of the 21st Century, 2007; National Science Board, 2010; PCAST, 2010). As such, there is a growing interest across the country to introduce technical, mathematical, and scientific skills and concepts to all children as early as possible in elementary and middle school, throughout formal and informal education settings.

Unfortunately, women and people of color (African-American, Latino, Native-American) are grossly underrepresented in obtaining secondary degrees in STEM as well as in careers dealing with subjects. For example, in 2008, only 17% of computer science (CS) advanced placement (AP) test takers are women, while they made up 55% of AP test takers and 51% of the population. Minorities constituted only 11% of CS AP takers and 19% of all AP test takers (CSTA, 2011). Additionally, according to the National Science Foundation (2008), African-Americans and Latinos, for example, each secured only 8.2 percent of undergraduate degrees in computer and information, whereas their white counterparts secured 63.5 percent. Social scientists have theorized that this disparity is not due to a lack of interest in these fields on the part of African-American and Latino students, but instead to a lack of their exposure to quality (formal and informal) educational opportunities in advanced science and math courses (Margolis et al., 2008). In public schools serving the fewest Latino and African American students, 82 percent offer Algebra II, 66 percent offer Physics and 55 percent offer Calculus. For schools serving the most African American and Hispanic students, 65 percent offer Algebra II, 40 percent offer Physics, and only 29 percent offer Calculus (United States Department of Education Office for Civil Rights, 2012). Additionally, research studies suggest that although girls express interest in math and science at similar rates as boys, somewhere between that initial interest and college graduation, they are discouraged from pursuing those interests. Reasons may include stereotypes, lack of confidence, and lack of exposure and understanding which leads to a lack of STEM career choices (CSTA, 2011; Hill, Corbett, & St. Rose, 2010; Modi, Schoenberg, & Salmond, 2012 ).

**Problem Definition**

Uplift, Inc. was founded as a response to this gap in education opportunities; it attempts to eliminate this gap by offering educational experiences in STEM to students between the ages of 4-19. Uplift’s mission is to immerse students, especially those of color, in STEM concepts as they exercise critical and computational thinking skills by attempting to solve and respond to real-world and imagined problems. The organization’s learning environments use culturally relevant, project-, and inquiry-based pedagogy and offers a series of classes that progress in difficulty from beginner to advanced. Students interested in learning about technology, computer science, and computer programming are first required to take an introductory course that familiarizes students with 31+ computer parts and their functions. For many participants, however, visualizing the function of each part without being able to see the part in action proves to be extremely challenging. At times, this lack of understanding creates confusion, lack of confidence in truly understanding computers, and can prevent students from excitedly moving on to more advanced classes (i.e. computer programming).

**Training Audience**

The training audiences for this module are middle school students in Uplift's beginning STEM courses, many of whom attend public and charter schools in Washington, DC. Although this module incorporates culturally-relevant pedagogy, target students are not limited to those who are African-American, Latino, and/or Female. Uplift's goal in implementing culturally-relevant pedagogy is for all students to learn about and appreciate the contributions by African-American, Latino, and Women computer scientists. Secondarily instructors of the target course are also considered in the design, as they will use it to administer and achieve learning goals and outcomes.

**Instructional Goals**

The goals of this training module include providing Uplift’s beginning STEM students with visual explanations and representations of how computing parts work, individually and collectively, in order to better prepare them for subsequent classes. Additionally, this module aims to encourage students to pursue careers in STEM fields, including computer science, by educating students about contributions to the field of computing by African-American, Latino, and Women computer scientists.

**Learner Analysis**

How Computers Workwill be implemented as a supplementary digital training module intended to be used by students at within the Introduction to Computers Course in Uplift’s learning lab with the use of computers. Currently, this introductory course includes lectures, demonstrations, and computer replica building projects.

The Instructional Design Team for How Computers Work have considered various needs of the target population to create this module for Uplift Inc. Since the How Computers Work module will be created for beginning students in Uplift’s classes, data collection for learner analysis included demographics from DCPS students as well as from students previously enrolled in the class. As a result, the goal is produce a cognitively accessible module, functional for students of a variety of academic levels and needs.

**Target Population**

* Students in grades 6-8 (ages 11-13)
* Middle school students from DCPS
* Students of all races, ethnicities, genders, and families from all SES (socio-economic status) levels
* Students new to Uplift's STEM classes

**Factors Included in Learner Analysis**

* Ethnicity
* Reading Ability
* Technology Use (Technology ownership was not a factor)
* Background Knowledge of Computers
* Interest and Motivation to Learn about Technology

**Student Data Collection Methods.**

Primary Data:

* + Interviews from Uplifts Instructors (Responses in Table 1 below)
	+ Analysis of Previous Students enrolled in course

Secondary Data:

* + Demographics from DCPS students (Figure 1)
	+ Analysis of potential students in course

**Table 1**

*Interview with Uplift In. instructors*

|  |  |
| --- | --- |
| **Interview Question** | **Response** |
| What are the ages and grades of students enrolled in Introduction to Computers course? | 6-8 grade students. Ages 11 through 14 |
| Are the students interested in the content? | Yes |
| Can students type efficiently? | No. Most students peck keys using one or two fingers. |
| Are the current students able to navigate digital mediums? | Yes. Students are able to navigate through most websites and software using the mouse and keyboard. |
| What part within the current Introduction to Computers programs do the students have the most difficult time understand? | Making connection between the computer part and their function. |
| Do you have students with a variety of learning needs or enrolled in special education? | Some students may have various learning needs. We don’t collect specific data, but some parents may show their students IEP’s so we can support their needs in the course.  |
| Do students have any physical barriers to accessing computers? | No |
| Approximately, what percentage of students have difficulty with reading or comprehension? | 40% |
|  Approximately, what percentages of your incoming students have background knowledge of computer parts and their function? | 5% |
| Approximately, what percentages of your students have consumer knowledge (understanding of use from personal use, commercials, ads, friends, and family) of technology? |  98%. Most students only have consumer knowledge.  |

**Student Ethnicity**

Uplift Inc. aims to engage students in culturally relevant material within their classes; therefore, data of student ethnicity was collected from Uplift’s current students and DCPS students. The following table represents the ethnicity percentages of students currently enrolled in Uplifts program and DCPS students.

*Figure 1:* Percentage of students by ethnicity in Uplift and DCPS

**Ethnicity: summary and implications.**

Washington D.C. students as well as the currently enrolled students in Uplift’s program are comprised of mostly African American and Hispanic students. To support Uplift's goal of engaging underrepresented students (African-American, Latino, and female students) in STEM careers, the module will include information on the contributions of African American, Latino, and Women computer scientists. This recognition will increase the awareness and appreciation for contributing scientists to the field of computing for all students, regardless of race/ethnicity.

**Reading Comprehension Levels**

Since the How Computers Work module will include on screen text, the reading levels of the students must be analyzed to develop a module that is accessible to the majority of students reading levels. The following table (Table 2) compares special education, English Language Leaners, and students reading below grade level between DCPS and Uplift’s students.

Table 2.

*Comparison of reading levels between DCPS Middle School and Uplift students*

|  |  |  |
| --- | --- | --- |
|  | Uplift | DCPS |
| Reading Below Grade Level | 42% | 85% |
| In Special Education | N/A | 18% |
| English Language Learners | 0 | 10% |

**Reading comprehension levels: summary and implications.**

More than half of the students enrolled in DCPS are reading below grade level and f43 percent of students currently enrolled in Uplift’s program have difficulty with reading and comprehension (Table 2). Special Education consists of a broad inclusion of disabilities; however, students within special education may have difficulties with reading and comprehension. Due to the possible issues with student reading and comprehension, the text featured in this instructional module should be written at a lower level than the lowest grade in the target population, sixth grade, to accommodate students with difficulties in reading. Therefore, the text in this *How Computer Works* program will be written on the third grade level.

**Technology Use**

How Computers Work will be delivered using a computer and digital formats. Therefore, secondary data regarding home technology and computer usage was collected to assess the student’s computer use. Computer use and experience may impact student efficiency with navigating through the module.

**Uplift Inc.**

According to the teacher interview, students are not generally able to type efficiently but can navigate through websites and most students use computers at school, although some do not have access at home. Teachers at Uplift do not have additional data regarding at home technology use.

**DCPS**

For classroom computer availability in the United States, ninety seven percent of schools that are comprised of fifty to seventy five percent of students that receive free or reduced lunch, similar to DCPS demographics, have at least one computer in the classroom with a ratio of three instructional computers to two classrooms (NCES, 2008). Additionally, most teens access the Internet using the computer or laptop (Pew Research, 2011).

**Technology use: implications.**

Student access to and use of technology is greatly varied within Uplift’s program as well as with DCPS students. Due to the statistics of students in Washington D.C. home and internet access and use, How Computers Work should have simple navigation for students who may not frequently use computers or the internet. Additionally, the module should have limited typing since most students are unable to type quickly and efficiently.

**Background Knowledge and Motivation**

Uplift's instructors state that students are very interested in the coursework and are extremely motivated to learn the content, but have difficulty creating abstract representations which creates a difficulty in understanding how computer parts work and how that relates to their overall function.. Additionally, instructors reported than an average of five percent of students have background knowledge of computer parts and their function and that all students essentially have consumer based knowledge of technology (from ads, use, friends, or family).

**Background knowledge and motivation: Implications.**

Since students enrolling in the course generally have consumer knowledge of technology, the module will be developed to help students transfer their consumer knowledge to a functional knowledge of the understanding of how computers move and manipulate data. For example, images of the latest smartphone, videogame console, and computers/laptops will be featured as illustrations of computing devices along with their internal parts and pieces.

**Learner Characteristics Summary**

DCPS schools are culturally and academically diverse and include varying levels of technology use and background knowledge. Aspects of Universal Design will be applied in development of the module to engage as many students as possible with the content. Universal Design attempts to enable people of various ability levels to access content and materials (NCS, 2011).

**Universal Design Application**

Universal Design will be applied in the follow aspects within How Computers Workbased on implications from collected data:

* Equitable Use - The screen reading level will be at a third grade reading level to accommodate the lower reading level of some students. This will allow the greatest amount of students to read without assistance. Options for text to speech will also be included in the module.
* Flexibility in Use - Portions of the module will be self-guided to allow for students to investigate computer parts at their own pace. Laptops will be used in lieu of desktops to account for students who may have physical barriers to standard computer desks and to enable students to comfortably travel around the learning environment.
* Perceptible Information - The module will not be overly intricate and concepts will be arranged from simple to most complex. The module will provide appropriate feedback after correct and incorrect responses.
* Tolerance for Error - Unnecessary or hazardous buttons ( ex: buttons that may cause work to be lost or accidental exit) will not be included. Instead, buttons will be optimally sized for the target audience.
* Low Physical Effort - The module will require limited physical effort. Students will be required to point and click using the available mouse or trackpad, scroll through content as needed, and wear headphones to listen to audio components of the module.
* Size and Space for Approach and Use - On screen text will be at a readable size for most users and important information presented using contrasting colors. The module will include options for font size increase and color change for students with visual impairments.

**Context Analysis**

**Organizational Information**

Uplift Inc. is a nonprofit organization, which operates at one location in Washington, D.C. The company receives its funding through various grants and initiatives that focus on the education and engagement of minority students in STEM fields. Uplift is headed by a director, with additional support from an assistant director assistant and five instructors. The director, assistant and instructors are either current STEM professionals and/or STEM instructors for other K-12 students.

Table 3.

*Structure of Uplift, Inc. afterschool program*

|  |
| --- |
| Enrollment |
| * Students are recommended by home school and enrolled by parents
 |
| * July and August enrollment for Fall semester
 |
| * December Enrollment for Spring semesters
 |
| * A prerequisite for other STEM classes (i.e. programming, robotics, app development)
 |
| * Grant funded
 |
| * Free to students
 |
| * Average of 15 students per class
 |
| Duration / Course Info |
| * Six week course; one or two evenings a week
 |
| * Occasional Saturday meetings
 |
| * 90 minute class with snack break
 |
| * Instructors plan to use How Computers Work as a supplementary material within Introduction to Computers Course
 |

**Previous Training Attempts**

Introduction to Computers is traditionally taught face-to-face without a digital component. Current instructors of the course have relied on worksheets, videos, and hands on activities to help students understand each computer part and their function. The structure of a typical session of *Introduction to Computers* includes a lecture, hands-on group work with an accompanied worksheets and follow up independent practice, which is usually in the form of an additional worksheet or building a computer. Instructors have expressed that within a typical session, the students continue to have difficulty understanding how computers parts function and how that relates to the overall inner workings of all computers, connecting the computer part to their function. Additionally, staff has stated that, since there is only one instructor, it is difficult to provide support to many groups during hands on activities, especially if one group in particular is having difficulty with a concept. Instructors also state that independent practice and assessments scores are very low, which reflects a lack of understanding.

**Site Information**

The site used for the implementation of How Computers Work will be a learning lab at Uplifts facility located in Washington, D.C. The learning lab is equipped with twenty-two Dell laptop computers purchased in 2011 running the Ubuntu (Linux) operating system, with up to date software and adequate desk space. The facility also has internet connection. The site includes all tools necessary, including adequate numbers of computers and facilitators, for application of the How Computers Workmodule. Students, who will be working individually for most of the module and will have individual workspaces.

**Context Implications**

The location of the training, which includes the computers and internet connection, can support a digital based module. The staff anticipates, on average, fifteen students to be enrolled in the course and the site includes enough computers for each student to complete the module. Since students are challenged with grasping some concepts (i.e. how a hard drive works inside its casing), a digital module geared towards students consisting of text, images, sound, and video representations of each computer part, how it works, and what function it performs to make a computing device work, will help with reinforcement of the concepts taught. This module should be self-paced which also allows for students to work through it with little help or without instructor support.

**Task Analysis**

**Topic Analysis**

In order to determine the appropriate form of a task analysis, we have familiarized ourselves with the computer science curriculum at Uplift and discussed class content and existing gaps in material with an Uplift instructor who served as a subject matter expert (SME). We have concluded that for this case, the topic analysis process is the most appropriate out of the three forms of the task analysis*.*

During the *Introduction to Computers* course at Uplift students learn facts, concepts, principles about computer parts and how each part performs in order to make a computing device function. The goal of this *How Computer Work* module is to enhance the course by: a) making material about the inner workings of computer parts more accessible through graphics, multimedia, and first-hand experience and b) introducing facts about outstanding African-American, Latino, and Women computer scientists, as a method of engaging students of color in computer science by fostering culturally relevant connections (i.e. culturally relevant pedagogy). This module includes details on six types of computing devices, five functions every computing device performs, an outline of thirty one computer parts that would be included in the full program, as well as a portion of the task analysis on minority computer scientists.

**Task 1- Introduction to the How Computers Work Module**

1. This unit will provide an overview and tutorial information on the content to be presented, how to: a) login, logout, and navigate within the module, b) adjust settings, c) track progress, and d) complete tasks and quizzes.

**Task 2 - Types of Computers (Computing Devices) and Why We Use Them**

1. **Computers in Society** (Types of computing devices used today)
	1. Laptops
		1. Describe laptops
			1. Identify based on images
			2. Explain unique features and functions
	2. Desktops
		1. Describe desktops
			1. Identify based on images
			2. Explain unique features and functions
	3. Phones
		1. Describe Phones
			1. Identify based on images
			2. Explain unique features and functions
	4. Tablets
		1. Describe Tablets
			1. Identify based on images
			2. Explain unique features and functions
	5. Gaming Systems
		1. Describe gaming systems (hand-held and home-based)
			1. Identify based on images
			2. Explain unique features and functions
	6. Smart/Mobile Phones
		1. Describe Smart/Mobile Phones
			1. Identify based on images
			2. Explain unique features and functions

NOTE: This document will refer to all six types of computing devices listed above as computers

**Task 3 - Function of Computer Systems**

A. Describe the difference between data and information.

1. Describe how computers work with/manipulate data (details below).
	* 1. Categorize computer parts by their five different data functions
			1. **Input** - used to input data into computing devices

Define input device (computer part)

Identify example - keyboard, mouse

Locate where (how) it is connected

* + - 1. **Store** - Parts that help to keep information in the computer

Define storage device (computer part)

Identify example - hard drive, memory

Locate where (how) it is connected

* + - 1. **Move** – Parts that move information throughout computer

Describe function of moving device

Identify example - data cables

Locate where (how) it is connected

* + - 1. **Output** - Used to output data from computers

Define output device

Identify example - printer, monitor

Locate where (how) it is connected

* + - 1. **Process -** There is only 1 process part of the computer (CPU). It handles all instructions, computation, and controls every other part of the computer.

Describe function of process part

Identify example- CPU

Locate where (how) it is connected

**Task 4 - Computer Parts and Their Function**

 **-**31 computer parts would be included in the full software

1. **Introduction of Computer Parts and their function**
2. Central Processing Unit (CPU)
3. Describe CPU
4. Define CPU
	1. Hardware of computer that carries out central input/output functions
	2. Brains of computer
	3. Takes information and makes the next steps
5. Identify How a CPU looks
	1. Identify image of CPU
	2. Compare image of CPU to other computer parts
6. List Common names for CPU
	1. Processor Modes
	2. CPU States
	3. CPU privilege levels
7. Explain How a CPU works
	1. List parts of CPU
	2. Describe how the parts work together to become central process for computer
8. Motherboard
9. Define motherboard
10. Describe function of a motherboard
	1. Holds crucial components of computer system
11. Identify How a motherboard looks
	1. Identify image of motherboard
	2. Compare image of motherboard to other computer parts
12. List Common names of motherboard
	1. Systems board
	2. Mainboard
	3. Planar board
	4. Logic board
13. Explain how a motherboard works
	1. Parts of a motherboard
		1. How parts work together inside of motherboard
	2. Describe how a motherboard works with other parts
		1. Parts that motherboard connects to
		2. how these parts work together to move information
14. Memory
15. Define memory
16. Describe function
	1. Storage function of computer
	2. Data storage in the form of a chip
		1. Definition of data
		2. Definition of chip
17. Identify How Memory looks
	1. Identify image of a memory chip/card
	2. Compare image of memory to other computer parts
18. List Types of memory cards
	1. PC Card
	2. Flash memory
	3. SD card
19. Explain How a memory card works
	1. Identify parts of memory card
		1. Describe how parts work together inside of memory card
			1. Parts that memory card connects to
			2. How these parts work together to store information
20. Hard Drive
21. Define hard drive
22. Describe function
	1. Storage function of computer
	2. Magnetic storage device for computer
	3. Records data
23. Identify how hard drives look
	* 1. Identify image of a memory chip/card
		2. Compare image of memory to other computer parts
24. List common names of hard drive
	1. Hard disk drive
	2. Hard disk
	3. Disk drive
25. Explain how hard drive works
	1. Identify parts of hard drive
		1. Describe how parts work together
	2. How hard drive connects to other computer parts
		1. Identify parts hard drive works with
		2. Describe how they work together to store information for computer
26. Data Cable
27. Define data cable
28. Describe function
	1. Transmits information to a receiver
29. Identify How a data cable looks
	1. Identify image of data cable
	2. Compare data cable to other computer parts
30. List Common names for data cables
	1. Ethernet
	2. Coaxial
	3. Optical Fiber Cable
31. Explain how a data cable works
	1. Identify parts of data cable
		1. Describe how these parts work together
	2. Describe how data cable works with other parts to move information
32. Computer Monitor
33. Define monitor
34. Describe function
	1. Electronic display for computers
35. Identify how a monitor looks
	1. Identify images of computer monitors
	2. Differentiate computer monitor from other computer parts
36. List common names of monitors
	1. Display Screen
	2. Touch Screen
	3. Screen
37. Identify types of monitors
	* 1. Show examples
	1. CRT – Cathode Ray Tube
		1. Pros
* have good color and resolution, allows the use of external
* devices like light pens and light guns
* Cons heavy
* large
* consume more power
	+ 1. how a CRT monitor works
	1. LCD - Liquid Crystal Display, a later version than CRT monitors
* Pros consume low power
* compact and slim
	+ 1. Cons
* limited colors and contrasts
* not many viewing angles
* blocky-looking picture
	+ 1. how a LCD monitor works
	1. Plasma screen/ plasma monitor - one of the latest type of the monitors
		1. Pros
			1. consume low power
			2. very good viewing angles,
			3. great color and contrast
		2. Cons
			1. heavy
			2. can only be made large
			3. can’t attach light pens or guns
1. Explain how a monitor works
	* 1. Identify parts of monitors
		2. Describe how parts work together
2. Mouse
3. Define mouse
4. Describe function
	1. Inputs data commands into the computer
5. Identify how a mouse looks
	1. Identify image of a mouse
	2. Compare data cable to other computer parts
6. List Common names for mouse
	1. mouse
	2. mice
	3. track pad
7. Explain how a mouse works
	1. Identify parts of mouse
		1. Describe how these parts work together
	2. Describe how mice work with other parts to input information

**Task 5 – Computer Scientists of Color, Women (Underrepresented Minorities in STEM)**

 **-**Fifteen examples of computer scientists will be included in the full software

1. **Introduction of Computer Scientists of Color and their accomplishments**
	1. Identify computer scientists of color
	2. Describe their accomplishments.
		1. Dr. Mark Dean
		2. Dr. Luis von Ahn
		3. Dr. Cynthia Breazeal
		4. Dr. Evelyn Boyd Granville

**Instructional Objectives**

Upon completion of the course, students will be able to:

* Name six (6) types of computing devices used today and identify their unique characteristics
* Describe and List the functions of 31 of the 31 computer parts (100% correct)
* Recognize, Identify and differentiate 31 computer parts
* Accurately locate where and how each computer part is connected inside/outside of a computer
* Distinguish and describe the difference between data and information
* Explain how computers work with (manipulate) data
* Categorize of computer parts by their five different data functions
* List at least 10 computer scientists of color, female
* Describe the life of 10 computer scientists of color
* Define and explain the importance of the achievements of 10 computer scientists of color

**Instructional Approach**

**Overview**

Students will interact with the How Computers Work module either in the middle or at the end of each class session in the Introduction to Computers course. This module will review and reinforce material covered in class by the instructor about computer parts and their functions. During each class session, one or two computer parts and their function will be discussed. After instruction on a specific computer part, students will be able to participate in the interactive computers module using the online software. The interactive software will present each computer part individually and its function (a total of 31 parts), and will guide the student in specific activities. The software will feature animations and rich graphics demonstrating each part along with narrative text descriptions - all of which will play at the user's control.

**Modules**

The software is broken into two major unit categories, computer parts and computer scientists. Each computer parts unit (content and activity tasks) is then broken into categories on specific computer parts and their functions. Students will also have the option of learning about computer scientists of color and their contributions to the field. All units in this module will feature images, text, audio, narration, and video.

**Instructor and student controls**

Two additional components are also featured within the software; a student portal and a teacher portal .The student center enables students to keep track of their progress, select individual activities to perform, and select and adjust various settings (i.e. size of text, sound on/off, etc.). The teacher center allows instructors to assign individual units to each student individually or as a class, adjust various global settings, monitor student progress, and assign or delete students in their class. The assignable activities include tutorial regarding the five functions computer parts perform as it relates to data (input, move, process, store, output), simulations of each part performing its appropriate function, guided practice activities (matching, identification of parts) to ensure and assess acquired knowledge and understanding of each part, along with drill and practice related to how all part fit together to form a computer.

**Accessibility**

The software is designed with universal design principals of Universal Design. Universal Design is a set of principles that help individuals with a variety of needs access the environment. To accommodate users of a variety of levels, text will be written on a third grade level, there will be options for text to speech and questions will be ordered by complexity. Additionally, high contrasting colors will be used throughout the software to assist individuals with visual impairments.

**Instructional Sequence**

The How Computer Works module will present its content in a logical sequence. Initially, students will be guided through Task 1, which introduces students to how to use and navigate through the module. Since students have consumer awareness of various technology products, logically, the next unit presented to them will be those associated with Task 2, the six types of computer devices commonly used today. A subset of Task 3 (introduction to data and information) will be reviewed in lecture format initially, followed by its respective unit in the module. The remaining portions of Task 3 (five functions of computing devices) will be interspersed with Task 4 (introducing the 31 computer parts) at the discretion of the instructor, pending what order these are presented in the lecture and his/her judgment of how well students understand the material. Task 5 (women computer scientists and those of color) will be also be presented at the discretion of the instructor depending on the knowledge and level of engagement of the students. It is also important to note that this unit is designed to stand-alone and can therefore be used to introduce the module, done by the student at-will, and/or presented in a logical sequence with the other content of the module.

Table 4.

|  |  |  |
| --- | --- | --- |
| Module Unit | Objectives/Activities | Time |
| Task 1 - Introduction and Tutorial Unit | Unit Objective: This unit will provide an overview and tutorial information on the content to be presented, how to: a) login, logout, and navigate within the module, b) adjust settings, c) track progress, and d) complete tasks and quizzes.This unit will feature screen captured examples, text, audio, and video. | 5-10 minutes |
| Task 2 - Types of Computing Devices | Unit Objective: Name six (6) types of computing devices used today and identify their unique characteristicsActivity 1- Types of Computing devices* Objective: Name 6 types of computing devices used today (i.e. laptop, desktop, tablet, mobile phone, game system) and why we use them (i.e. data manipulation, information sharing, faster processing, game play, etc.)
* Presentation (Rich Images, Text, Narration): Students will be shown images of five computers. The name of each computing device will be presented to with text. Students can click on each type of computer to read a description of the computers visual traits and their function. Text will be presented with audio narration.
* Activity: Students will match images of computing devices with words describing their type (listed above) for a matching activity. When matched correctly, the text will align with the picture and various uses of that type of device will be stated in audio. If incorrect, the image and text will go back to their original places on the screen. Students will be prompted to try again.
 | 10-15 minutes |
| Task 3 - Five Functions of Computer Parts (Input, Process, Store, Move, Output Data) | Unit Objectives: * Distinguish and describe the difference between data and information
* Explain how computers work with (manipulate) data
* Categorize of computer parts by their five different data functions

Activities - Types of Computer Parts (5 main functions)* Explanation of the difference between data and information which supplements lecture.
* Presentation (Animation): Graphics and audio with accompanied text will show the five types of computers. Each function will be described (text/audio) with images of the various parts that perform that function (i.e. input - mouse, keyboard, etc.)
* Guided Practice Activity 1: Audio/text will guide students to click specific parts of the computer relating to the five functions .Arrows and highlighted computer parts will guide students to click specific parts. Once clicked, audio/text will state that the student found a certain part with that function.
* Guided Practice Activity 2: Students will sort images of computer parts by function into input, output, moving information, and storage into various sections of the screen. Students may click icon to receive a hint for particular computer parts.
 | 25 minutes |
| Task 4 -31 Computer Parts | Unit Objectives:* Describe and List the functions of 31 of the 31 computer parts (100% correct)
* Recognize, Identify and differentiate 31 computer parts
* Accurately locate where and how each computer part is connected inside/outside of a computer

Introduction Activity: A brief overview of the selected computer part will be presented. Students will navigate through five slides that include a brief definition, image, and video as an introduction to the activities about the specific part. Activity Set1- Images of computer parts* Presentation (Animation & Simulation): Rich images (from various angles) and 2D animations will provide simulations of individual computer parts. Text and audio will describe how the specific computer parts look. During the presentation, the common names of the computer part will be presented.
* Activity: Students will be given a name of a computer part. Students will then be presented with a series of five images of different computer parts from various angles. The student will click the computer part that matches with the name given. Incorrect answers will receive a prompt with a hint.

Activity Set 2- Function of Computer Parts* Presentation: Image of individual computer part will be shown both in isolation and inside of the computer. Text/audio will present the function of the computer part and parts that the computer part works with to complete the task. Students will be able to click the computer part and the parts that it works with to see (and read) how they interact with each other.
* Guided Activity: Students will be presented with the individual computer part and a list (text and audio that plays when clicked) that describes various functions of computer parts. Students will drag and drop the text that states the function of that computer part under the picture of the computer. Incorrect answers will go back to their original spot in the list.
* Cumulative Activity: After the presentation and guided activity for all computer parts, students will be shown an image of a computer part and its name and five options of the correct function. Students will click the correct function for that computer part.

Activity Set 3- Data and Information* Objective: Describe the difference between data and information
* Presentation (Animation): Students will be presented with text/audio that states the definition of data and information. The text/audio will describe the differences of data and information by showing text items and placing it under data or information categories.
* Activity- Students will be presented with two categories: data and information. Students will have to drag and drop text from a list to either the data or information categories. Feedback will be provided for correct answers, incorrect answers will return to their original spot in the list.

Activity Set 4- Computers and Data* Objective: Explain how computers work with data
* Presentation (Animation): Students will be shown an animation of a computer which highlights specific computer parts and how they store and transfer data. Students will be able to click specific computer parts and hear audio reinforcing information about the part and how it transfers data.
* Activity 1: Students will be shown an open computer. Students will be prompted to transfer information between parts of the computer. Students will be required to connect parts (by clicking images of parts inside of the computer) together to transfer data. With correct answers, data will transfer. Incorrect answers will receive a hint.
* Activity 2: Students will be shown three animated students that hold cards that contain information about data and computers. Students can click on each student to hear the student explain the fact. Only one student has a correct fact. Students will click the student that has the correct fact about data and computers.
 | 5-7 min per part (presentation)10 minutes per activity |
| Task 5 - Computer Scientists | Unit Objective:* List at least 5 computer scientists of color, female
* Describe the life of 5 computer scientists of color
* Define and explain the importance of the achievements of 5 computer scientists of color

Activities: * Students will be presented with 15 portrait pictures and names of computer scientists and will be asked chose one by clicking on it
* Students will be shown a short video describing the key events in the life of the selected computer scientist
* Students will then presented with two specific contributions and explained their importance with a fun facts
* Students will be required to take a quiz after the “contributions animation”
* Students will take a quiz that will consist of 7 multiple choice trivia questions concerning facts about scientist’s life and achievement.
* Students will be presented with their score and shown correct answers after the quiz completion
 | 5-15 minutes per computer scientist (pending student interest) |
| Teacher Portal | Within the teacher portal, instructors will have the ability to:-Assign specific category to students-Assign specific category activities to students -Set mastery level for student achievement.-Reassign individual sub-categories to students who do not meet mastery.-Monitor Student Progress-Create Reports-Disable/Enable free play game option-Disable/Enable video clipsInstructors will also be able to change specific accessibility features for students:-Change font: size and type-Change background and text color-Disable/Enable sound-Disable/Enable text to speech feature-Disable time restrictions | N/A |
| Student Portal | Within the student portal, students will be able to:-Select and engage in teacher assigned modules-Monitor completion progress within individual modules-Review scores within each module-Play computer parts gamesStudents will have access to alter the following settings:-Volume control-Font size | N/A |

**Limitations and Constraints**

 The major limitation of Uplift Inc. is number of computers. Each student in class will need a computer in order to learn and practice the material individually. Additionally computers will need to be current with up-to date software.  Although presently there is a sufficient number of computers, it could happen that once in a while there will be more students in class than computers and thus not every student will be able to access digital learning module.

**Instructional Materials**

The deliverables for this course include:

* *How Computers Work* (digital module)
* Content outline and accompanying instructional strategy
* Facilitator guide
* Recommendations for Visuals/job aids/posters/printed/audio-visual supplementary resources (to match the images within the module)

**Evaluation Methodology**

The design, development, and implementation of How Computer Work will involve formative, summative and confirmative methods of evaluation. The formative evaluation used during the design process is presented first followed by the summative evaluation method used once How Computers Work has been implemented. The design team will obtain IRB (Institutional Review Board) approval before any evaluations are conducted.

**Formative Evaluation**

The purpose of this evaluation is to examine whether the instructional materials are accessible, content is appropriate, and the time allocated for each module is achievable. The intended audience for the evaluation results includes Uplift Curriculum & Instruction Team, afterschool program instructors, 50 percent of 6-8 graders in the afterschool program, and course designers. Required resources involve data collection and analysis instruments (i.e. computers to answer the questionnaires for students and instructors, internet access, Survey Monkey, SME to correct and/or make changes in the content if Uplift Curriculum & Instruction Team recommend for such changes).

**Formative evaluation audience.**

* Uplift's Curriculum & Instruction Team
* Instructors
* Students

**Uplift's curriculum & instruction team.**

Uplift's Curriculum & Instruction Team will review the content of the module to determine whether the content meets the requirements and standards of the course. They will be asked to write recommendations for potential revisions. After addressing all the comments, and securing the approval of the executives, the program will be beta-tested by the instructors and students.

Sample Questions for the Curriculum & Instruction Team Include:

**Small group testing (pre-testing, embedded testing, and post-testing).**

Students and instructors will participate in small group testing. After each class, instructors and students will be asked to respond to a questionnaire using Survey Monkey program. Questions will vary depending on the day, and will be used for formative and summative evaluations.

**Pre-testing/ post-testing- portal.**

 Instructors and students will be asked to fill out Survey Monkey questionnaire concerning the workings of the modules teacher and student portals. Their answers will be used to change/improve features during the beta-testing time.

***Sample questions for instructors may include:***

How hard it is to set mastery level for student achievement:

 1 2 3 4 5

 Hard Somewhat Hard Not Hard But Not Easy Somewhat Easy Easy

Comment \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Is it a useful feature: Yes No

If No, why \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

How hard is it to reassign individual sub-categories to students who do not meet mastery:

 1 2 3 4 5

 Hard Somewhat Hard Not Hard But Not Easy Somewhat Easy Easy

Comment \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Is it a useful feature: Yes No

If No, why \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

***Sample questions for students may include:***

How hard was it log in and log out?

 1 2 3 4 5

 Hard Somewhat Hard Not Hard But Not Easy Somewhat Easy Easy

If it was hard, tell us why\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

How hard is to review your scores within each module?

 1 2 3 4 5

 Hard Somewhat Hard Not Hard But Not Easy Somewhat Easy Easy

If it was hard, tell us why\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Pre-testing/post-testing: content.**

Content testing will require instructors and students to provide structured feedback for each module. This subset of questions will target mostly appropriateness of content and time allocation. As before, the feedback will be provided via computers using Survey Monkey questionnaire.

***Sample questions for instructors may include.***

Was the video presentation of five computers clear?

 Yes No

 If No, what can be done differently \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Was the matching activity appropriate?

Yes No

 If No, what can be done differently \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Did the module help and engage students in learning the name a computer scientist of color or a female computer scientist and identify the key events in the life of the said computer scientist?

Yes No

If No, what can be done differently \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Did the module help students to learn about the contributions of the computer scientist and the importance of the achievement of the computer scientist?

Yes No

If No, what can be done differently \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Did the students have enough time to complete the module?

Yes No

 If No, what took the longest\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

How long did it take most students to get through the module: \_\_\_\_ minutes

Questions for students will be essentially the same, although worded differently (age-appropriately).

Additionally, both students and instructors will participate in one role-specific focus group (one student and one instructor focus group) to discuss their overall impression of each unit in the module. The collective responses from these focus groups will provide qualitative data regarding the quality and impact of the module.

**Formative evaluation analysis.**

The ID team will compile scores for the likert-type scales, and means will be calculated. Questions that receive a mean score of 3 and below (answers: Hard and Somewhat Hard/ Confusing and Somewhat Confusing) will be individually examined, recommendations from students and instructors reviewed, and changes will be made when necessary. Average times for module completion will be calculated and compared to the numbers allocated by designers. In case of large time discrepancies between planned and actual time, changes will be made. Questions that require Yes or No answers will be coded 1 and 0 respectively. Those questions that receive low scores (i.e. predominantly No) will be examined individually and changes will be made when necessary.

Focus group responses will be analyzed for themes regarding features that were effective and those that were not. This data will be used to supplement the quantitative data analysis (described above) to determine how best to improve the design of the module.

**Summative Evaluation**

The purpose of this evaluation is to examine the effectiveness of the resulting module. To do that, students will be divided into control and treatment groups. Students in the intervention group's progress will be compared with the progress of student in the control group in the form of a survey, content mastery, and the. number of times it takes to review content before it is mastered. Additionally, the instructors and students satisfaction reports will be collected and reviewed. The first implementation of the module will occur in one of two *Introduction to Computers* sessions at Uplift. Instructors will be assigned, in teams of two, to teach both sessions. Upon admission to Uplift for both sessions, each student will take a pre-test to determine their knowledge of computer parts and function. After scoring of the assessment, the two classes will be structured with an equal distribution of low, medium, and high performers on the assessment, which will create similar mean scores between the two classrooms.

 The treatment group will receive traditional instruction with support of the digital modules. The control group will receive traditional instruction without the support of the digital module. At the end of the course, the two classes enrolled in *Introduction to Computers* course will take a quiz based on the course material. The multiple choice quiz will contain questions about each section contained within the *How Computers Work* module including function of computer parts, functions, and computer scientists. Additionally, students will provide feedback and answer questions concerning their career aspirations, enthusiasm, and satisfaction with the course. All instructors will be asked to provide feedback about their satisfaction, opinions about course effectiveness, etc.

***Sample instructor questions***

On a scale from 1 to 4, please rate useful was the computer module

 1 2 3 4

Not at all A little Somewhat Very much

On a scale from 1 to 4, please rate how enjoyable FOR STUDENTS was the computer module

 1 2 3 4

On a scale from 1 to 4, please rate how effective was the computer module in supplementing the course material

 1 2 3 4

Not at all A little Somewhat Very much

Sample student questions:

On a scale from 1 to 4, please rate how much you’d like to be a computer scientist when you grow up:

 1 2 3 4

Not at all A little Somewhat Very much

On a scale from 1 to 4, please rate how much would you recommend a friend to take this course:

 1 2 3 4

Not at all A little Somewhat Very much

On a scale from 1 to 4, please rate how much you have enjoyed this course:

 1 2 3 4

Not at all A little Somewhat Very much

**Summative evaluation analysis.**

The mean quiz-scores from the end of course quiz and the teacher and student survey will be separated by treatment and control group. The calculated means scores for the two groups will be compared using t-test to see whether the difference is significant in the areas of student mastery of course content, student enjoyment of the course, and support of module of class objectives.

**Confirmative Evaluation**

This goal of this evaluation is to see whether the program has long-term effects, and whether materials are still appropriate in terms of meeting the objectives.

 Each year, designers will attempt to collect additional information, about the participants over the period of 6 years (from current grade to graduation). This information will include participants’ interest in computer science in subsequent grades, the proportion of participants who picked computer science as their major in college, the number of participants who took computer science classes at school, when and where appropriately offered, etc.

 Twice a year, the design team will meet with Uplift's Curriculum & Instruction Team to determine the relevance and accuracy of the content according to new innovations and emerging technologies. Appropriate actions will be taken to upgrade the content, objectives, instructional strategies, and messages when necessary.

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