Contextualized Curriculum
for Adult Learners in Math and Literacy

What Will It Take to Build?

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How estimation skills are used by <u>web developers</u> *in planning the costs to build a new website.*

Industry Sector: Information Technology
Content Area: Mathematics
Core Topic: Measurement and estimation

Expand All | Collapse All

Common Core State Standards

Standards for Mathematical Practice:

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
6. Attend to precision.

High School—Number & Quantity: Quantities

N-Q.1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

N-Q.2. Define appropriate quantities for the purpose of descriptive modeling.

N-Q.3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

Adult Basic Education Standards

Number Sense:

N-3: Compute fluently and make reasonable estimates.

Industry Overview

From computer programmers to web developers, and from network administrators to technical support specialists caring for the IT infrastructure, there are information technology (IT) careers available in every sector of the economy. While some people in this field work for IT companies, IT skills and services are needed in fields as wide-ranging as financial services, medical services, biotechnology, engineering and environmental services[1]. The IT industry designs, develops, manages and supports the hardware, software, multimedia and networks we depend on in our daily lives and businesses. IT has revolutionized our world—from the ways we communicate to how we find information to how businesses operate. Job growth in the US IT industry is high and is projected to continue for many occupations within the industry. The field is constantly growing and changing and there are high levels of competition which makes it important for IT workers to keep updating their skills and to understand the latest technologies.

Careers in Information Technology[2]

Information technology careers are divided into four pathways: Network Systems, Information Support and Services, Programming and Software Development, and Web and Digital Communications.

Careers in Network Systems involve network analysis, planning and implementation, including design, installation, maintenance and management of network systems. Examples of network systems occupations include: network administrator, network technician, PC support specialist, telecommunications network technician, data communications analyst, and security administrator.

Careers in Information Support and Services involve IT deployment, including implementing computer systems and software, providing technical assistance, and managing information systems. Successful IT deployment is critical to the success of most organizations—the management and sharing of information depends on non-IT workers having functional computers, software and databases that meet their needs, and support when things aren't working. Information systems and support occupations include database administrator, enterprise systems engineer, help desk specialist, technical support specialist, and technical writer.

Careers in Programming and Software Development involve the design, development, implementation and maintenance of computer systems and software and require knowledge of computer operating systems, programming languages and software development. While many of the career opportunities in this area are in software companies, large organizations of other types—such as financial services— also offer many opportunities. Programming and software development careers include: software applications architect, operating systems designer/engineer, computer programmer, video game developer, applications engineer, and applications developer.

Careers in Web and Digital Communications involve creating, designing and producing interactive multimedia and social media products and services and include development of digitally-generated or computer-enhanced media used in business, training, entertainment, communications and marketing. Organizations of all types and sizes use digital media (such as the Internet and social media platforms) to communicate with existing and potential customers, to track transactions, and to collaborate with colleagues. Occupations in this pathway include web designer, webmaster, 3D animator, virtual reality specialist, and multimedia producer.

Mathematics and Literacy Skills Needed in Information Technology

The complexity of the IT industry, including the rapid pace of change in technology, requires workers to continuously upgrade their skills. Jobs in this industry require good problem-solving, critical-thinking, and reasoning; clear and professional communication; and a strong background in mathematics. Thus, in addition to technical skills specific to each job, mathematics and literacy skills are crucial for success in all occupations across the industry. Literacy is essential in this field as it is heavily dependent on written and oral communication, and workers need to be able to read, understand, and implement highly-technical content. Workers in this industry must communicate with clients, colleagues, and other departments and staff, including executives.

Regardless of how technologies change, a strong foundation in mathematics, particularly with such core areas as mathematical operations and number sense, measurement and estimation, ratios and proportions, and data analysis is very useful in this industry. For example, programmers and

developers must be able to employ quick and competent computation and have the ability to select and apply the best mathematical model or formula to solve problem at hand.

Career Opportunities in IT with Education from Community Colleges

Massachusetts Community Colleges play a crucial role in preparing students for careers in IT across all sectors of the industry. The fifteen community colleges offer associate degree and certificate programs that prepare students to enter occupations across all sectors of the industry, from network administrators to technical support specialists to computer programmers to Web designers. For example, Cape Cod Community College's Department of Business has an IT program that prepares students for a range of positions through both the Information Technology A.S. degree and certifications that offer skills in specific concentrations in this field, such as networking and web design.

Recent Career Opportunities in Massachusetts

The following is a sample of IT job listings in Massachusetts that require associate's degree or certificate:

- Help Desk Technician [show]
- PC Technician [show]

The following is information about hires of recent IT graduates from Massachusetts community colleges:

- Bristol Community College, Computer information Systems: Computer Networks
- Mount Wachusett Community College, Computer Information Systems

Employment Outlook for Information Technology

Given the ubiquity of IT in the U.S. and the world today, employment in this industry continues to boom. Even during the current recession, there has continued to be high demand for workers with good technical, problem-solving and critical-thinking, and communication skills in the IT industry. The U.S. Bureau of Labor Statistics reported in its 2012-13 edition of the Occupational Outlook Handbook that employment in the industry is expected to grow "much faster than the average" of all occupations through 2020. Massachusetts has very high levels of employment and numbers of job openings in many IT occupations across the state. In 2011, it was one of the top seven states for employment opportunities in the industry. Furthermore, Middlesex and Suffolk counties were among the top 20 counties nationally listing IT positions.

However, within the IT industry, job growth and openings vary due to technological changes and competition (especially foreign). For example, employment for computer programmers in Massachusetts and nationally continues to be high, but is declining—future jobs will go to people with strong technical, cognitive, intrapersonal, and interpersonal skills. Likewise, lower-skilled jobs such as computer support specialists will have lower employment growth due to outsourcing (though help desk personnel are always needed in larger firms to assist non-IT staff with maintenance, troubleshooting, and repair). The highest growth areas in IT—nationally and in Massachusetts—are in such occupations as computer and information systems managers, computer systems analysts, and computer specialists.

Resources

Employment Outlook

- Massachusetts Career Information System
- U.S. Bureau of Labor Statistics: Occupational Outlook Handbook, Computer and Information Technology
- Jobs for the Future: An Examination of the Information Technology Job Market (2012)

Occupational Information

- Massachusetts Career Information System

- U.S. Bureau of Labor Statistics: Occupational Outlook Handbook, Computer and Information Technology
- WorkKeys Occupational Profiles
- WorkKeys: Occupations and Key Skills
- Information Technology Career Clusters
- Information Technology Career Frames

[1]http://www2.edc.org/ewit/materials/ITCCBRO.pdf

[2]As cited in http://www2.edc.org/ewit/materials/ITCCBRO.pdf

Workplace Scenario (8th Grade Level)

This scenario is based on the work of a web developer. For more information, review this webpage.

You are a web developer. You work in the IT Department of a publishing firm in Massachusetts. The firm develops websites in house for each new product they launch. The staff from the IT department supports this work. You are part of a small team of web developers under the leadership of David. David is the Business Analyst. David is primarily responsible for interacting with staff from the publishing teams. He also leads the negotiations on the scope and specifications of each website. You and the other web developers have a key role in these negotiations too.

Many of the publishing teams only have vague ideas about website development. They may not have fully defined the scope and specifications. They may know how they want the site to look or how people might use it. It is your responsibility to figure out how best to achieve the desired results. Often, the publishing teams only begin to create the websites after finalizing the print materials. As a result, the timelines for development are usually very tight. In addition, there aren't unlimited resources for building the websites. You or one of the other web developers will work closely with David. You first review and refine the scope of work. You will then provide a timeline for the development. You also work together to estimate the costs to complete the work.

The publishing teams must get permission from higher management to develop a website. Therefore, it is essential that you provide very good estimates. You need to be able to specify the exact time and cost of building a website. You will be held to your estimates by David and the publishing team. Additionally, if there are problems with overruns, it could impact the firm's profit. For example, the launch of a new product could be delayed. It could also impact the finances of the publishing team. The publishing team is penalized for going over budget. The difference comes out of their operating budget.

Workplace Scenario (High School Level)

This scenario is based on the work of a web developer. For more information, review this webpage.

You are a web developer. You work in the IT Department of a medium-sized publishing firm in Massachusetts. The firm develops websites in house for each new product they launch. The staff from the IT department supports this work. You are part of a small team of web developers under the leadership of David, who is the Business Analyst. While David is primarily responsible for interacting with staff from the publishing teams and negotiating the scope and specifications of each website, you and the other web developers have an essential role in these negotiations.

Many of the publishing teams only have vague ideas about the scope and specifications of the work. They may know how they want the site to look or how people might use it, but it is your responsibility (or the responsibility of one of your colleagues) to figure out how to best achieve the desired results. Often, the publishing teams only begin to conceive the websites once they have finalized the content of the print materials. This means that the timelines for these negotiations and for developing the websites are usually very tight. In addition, there aren't unlimited resources for building the websites. Therefore, you or one of the other web developers will work closely with David to review and refine

the scope of work. You will then provide a timeline for the development. You also work together to estimate the costs to complete the work.

The publishing teams must get the approval of higher management to proceed with the website development. Therefore, it is essential that you be able to give very good estimates for the time and cost of building a website. You will be held to your estimates by David and the publishing team. Additionally, if there are problems with overruns, it could impact the firm's profit (by delaying the launch of a new product). It could also impact the finances of the publishing team. By using more resources than have been allotted to this work, the publishing team is penalized and the additional resources come out of their operating budget.

Core instructional context

Measurement and estimation are critical life and workplace skills that are used frequently by students throughout their daily personal and working lives. Measurement is both a necessary skill for geometry and a tool that people rely on to help make sense of their world and understand physical objects and experiences, such as the temperature. Estimation, likewise, is important for informal measurements such as having a sense of what size something should be, how much something should cost, or how long a task should take.

Most students use measurement many times in their daily lives for activities such as cooking, home repairs and scheduling. In hobbies such as woodworking, precise measurement is crucial. Given students' experience and dependence on measurement, it is likely that they will have a high level of interest in tackling problems using measurement, and they will have many relevant experiences to share. It's also likely an area in which they will have a high degree of confidence in their abilities.

Web developers design the look and feel of website pages and write computer code to build, edit, and repair websites. They may work in firms that design computer systems, but many work for other types of companies and organizations—from business management companies to large manufacturers to universities. Many web developers work as independent consultants or work from home at least part of the time. Web developers use mathematical skills in solving the problems they encounter in their work—from providing an estimate of the time and resources it will take to build a website to clients, to developing the design of the site so that it is visually appealing and easy to find what people are looking for.

Worked Example

The chart below describes the number of hours and cost per hour for each project component that back-end developers will be taking on. You can fill in the empty cells and estimate the total amount that the back-end developers will bill for this project.

Project Component	Hours	Average Cost per Hour	Cost
Site map development	48	$79	Answer: Should be close to $4,000
Database development	182	$79	Answer: Should be close to $14,400
Social networking, backlinks, search optimization	119	$79	Answer: Should be close to $9,600
TOTAL			Answer: Should be close to $28,000

a. One way to approach this estimation problem is to first round the numbers of hours. For example:

48 → 50
182 → 180

119 → 120

b. Then, you could round the cost per hour, so $79 could be rounded to $80.

c. For each project component, you could then multiply the estimated hours by the rounded hourly cost.

50 hr * $80/hr = $4,000
180 hr * $80/hr = $14,400
120 hr * $80/hr = $9,600

d. Then, you could add the total estimated cost for each project component to get a total estimated cost for the project.

$4,000 + $14,400 + $9,600 = $28,000

e. Comparing your estimate to the actual answer, you can determine how close your estimate is:

$27,571 is close to $28,00—they differ only by $429

Contextualized learning activities

A. Active Reading

Have students read the scenario—either as a whole group, in pairs, or to themselves. Ask them to circle or highlight math-related concepts and terminology. You may want to give them a little background on this scenario before or after the reading, such as the following:

Developing a budget and staffing for a web development project requires a working knowledge of how to make good estimates of how long the work will take and what kinds of expertise is needed.Since the details of a web development project often emerge over time, it is important to know the typical parts for any web development project, as well as how long (and how expensive!) each part will be.

After reading the scenario, ask students the following questions:

- What are the various tasks involved in web development?
- What are the challenges in developing a realistic budget for a web development project? Think about what information is needed to determine who gets involved, the number of people and hours, and the overall projected expense.
- How can estimation be helpful in developing a realistic budget?

B. Brainstorming

Ask students to brainstorm ways that math is used to help with planning a web development project. In particular, ask students if they can identify ways that estimation is used. Discuss the possible consequences of not having a good projection on the number of people, hours, and funds to complete a web development project.

C. Background reading

Have students read this article from a web style guide about planning site development. Tell students to pay particular attention to the core skill sets, the team roles and responsibilities, and the diagram of the timeline (fig 1.1). This resource will help them to understand the typical roles people have on a web development team and the structure of a web development timeline.

D. Contextualized problems

1. The table below describes the number of hours and cost per hour for each project component that front-end developers will be taking on.

a. Fill in the missing cells to estimate the total amount that the <u>front-end</u> developers will bill for this project.

Project component	People Involved	Hours	Average Cost per Hour	Cost
Design of screen wireframes	Graphic Designers	102	$68	Answer: Should be close to actual cost of $6,936
Design of refined website screen images	Graphic Designers	156	$68	Answer: Should be close to actual cost of $10,608
Image slicing	Graphic Designers	62	$68	Answer: Should be close to actual cost of $4,216
TOTAL				Answer: Should be close to actual total of $21,760

b. Estimate the total time that graphic designers will take on this project.

   Answer: Estimate should be close to actual value of 320 hours

c. If you have four graphic designers, and each will be spending equal amounts of time on the project, estimate how much time each designer will be spending on the project.

   Answer: Estimate should be close to the actual value of 80 hours

d. If each graphic designer can devote 25 hours per week on this project, how long will all <u>front-end</u> web development take?

   Answer: Just over three weeks)

Contextualized test items

1. You find out your vendor for StoryView, a new web development software for your designers, is offering a 35% discount on the software package. The program initially cost $1,400 and you were planning to order five copies for your development team. Given your overall budget of $30,000 for the project, estimate how much money will be left in the budget after purchasing the software.

   Answer: Estimate should be close to the real value of $25,450

2. 200 hours into the project, you find that the interactivity development has taken 60 hours (the original estimate was 48 hours). The developer's salary was projected at $68 per hour, but the actual costs are $75 per hour.

   a. Estimate how much more money this adds to your project costs.

      Answer: Estimate should be close to the actual difference of $1,236

   b. If you had a margin of $3,000 in your original budget, will this force your project over budget?

      Answer: No, this difference is within the budget margin

3. Your customer says they want the product two weeks earlier. Since you don't have any programmers on staff with additional time to devote to this project, you're thinking about using external consultants. These consultants cost $20/hr more than the employees at your firm. If you need five consultants to work for two work weeks at 8 hours a day, estimate how much will this add to your costs.

    Answer: $8,000

4. Use the data in the following table to answer the questions that follow.

Project Component	People Involved	Hours	Average Cost per Hour	Cost
Site map development	All developers (front-end and back-end)	48	$79	Answer: Should be close to actual cost of $3,792
Developing website CSS styles	Front-end developers	51	$79	Answer: Should be close to actual cost of $4,029
Development of interactivity	Front-end developers	72	$79	Answer: Should be close to actual cost of $5,688
TOTAL			Answer: Should be close to actual cost of $13,509	

a. Fill in the last column to estimate the total amount that the developers will bill for this project.

    Answers: See table

b. Estimate the total time that will be taken by front-end web developers. Assume they will do 50% of the site map development.

    Answer: Should be close to actual value of 147 hours

c. If you have 6 front-end web developers, and each will be spending equal amounts of time on the project, estimate how much time each developer will be spending on the project.

    Answer: Should be close to actual value of 24.5 hours

d. If each front-end developer can devote 20 hours per week on this project, how long will all front-end web development take?

    Answer: Just over one week

5. The chart below shows estimates for the percentage of time and budget that each group role on this project is expected to consume.

a. If you have budgeted 400 total days for this project, estimate how many hours you can allot to each role and fill in the third column.

b. Then, calculate the actual hours, record your answers in the fourth column, and see how close your estimate was for each role.

Role	Percentage of Time & Budget	Estimated Hours	Actual Hours

Layout Artists & Designers	13%	**Answer:** Should be close to actual	**Answer:** 416 hours
HTML/CSS Developers	18%	**Answer:** Should be close to actual	**Answer:** 576 hours
Management	14%	**Answer:** Should be close to actual	**Answer:** 448 hours
Back-end Programmers	19%	**Answer:** Should be close to actual	**Answer:** 608 hours
Usability Testers & Analysts	15%	**Answer:** Should be close to actual	**Answer:** 480 hours
Site & Content Planners	21%	**Answer:** Should be close to actual	**Answer:** 672 hours

6. If you want to make 15% profit via this website in its first year, and the site is expected revenue over the first fiscal year is $10,000, estimate how much budget you can allocate to this project.

> **Answer:** Approximately $8,500

Contextualized project

Find white papers on optimizing a website in order to obtain Google analytics information for the following scenario, which can be presented to students, or have students obtain this data for themselves. You might have teams look at the same data and present their findings individually or collectively.

You have started a new website to promote your new book. Your site has had the following activity over the last three weeks (you will need to fill in with information you obtain):

- # of hits per month
- # of visitors who completed a purchasing task
- bounce rate (% of visitors who leave after viewing just the homepage)
- Traffic sources (how did the site's visitors get referred to the site?)

Of the people who visited your website, what percentage bought the product? What was the resulting revenue?

Suppose your goal is to increase the number of sales of this book to 4,000 over the next two months, and that sales are proportional to the number of users visiting your site. Estimate the number of visitors you'd need to generate 4,000 book sales over two months.

Estimate how many hits would you need in one day if you wanted to sell 1,000 books per week?

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