

Innovations in Healthcare: Amazon Pharmacy

Key Student Learnings

Phenomena Question

How has Amazon Pharmacy innovated the traditional pharmacy experience to quickly and efficiently deliver customers' medicines?

How does automation help people fulfill customer orders faster?

Overarching Content Question

How do technology and people work together to help deliver safe and affordable medicine to those in need?



Vocabulary

Stop 0: Intro

Pharmacy

The science of preparing, standardizing, and dispensing medications to the public

Medication

A substance used for medical treatment

Stop 1: Rx Received

Ingestion

The process of obtaining or importing data

Artificial Intelligence

Technology that can imitate human behavior

Machine learning

The science of getting computers to perform an action based on past examples

Cells

The smallest building blocks of life

Medication Interaction

When two or more medications react with each other

Stop 2: Filling Prescriptions

Automation

The use of machines, robots, or computers to do tasks without needing a person to control them directly

Algorithm

A set of instructions for a robot or computer to perform

Input

Information or instructions sent to a computer

Processing

The thinking work a computer does to turn an input into an output

Output

Any information that is processed by and sent out from a computing device (i.e. text, video, sound, images)

Sensor

Hardware that can take in information from the environment and respond



Vocabulary

Stop 3: Quality Control and Shipping

Quality Control

A process used to ensure that a product or service is free from error

Computer Vision

Artificial intelligence that derives information from images, videos, and other inputs

Sustainably

Operating without depleting Earth's resources and harming the environment

Stop 4: Conclusion

Human-computer interaction

The study of how people interact with computers and to what extent computing systems are or are not developed for successful interaction with human beings



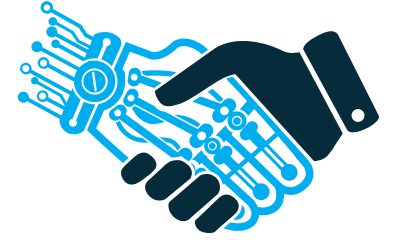
Intro

Innovations in Healthcare: Amazon Pharmacy

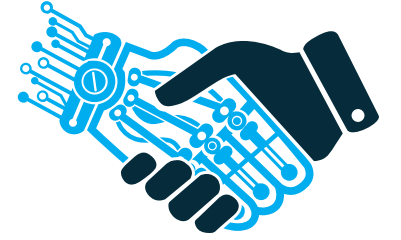
Watch this Tour Stop in: [Video 1](#) and [Video 2](#)

How does technology and people work together to help deliver safe and affordable medicine to those in need?

Over tens of thousands of years, innovation has improved peoples' access to healthcare. From using plants in prehistoric days to modern medicine, humans have been using medication to treat illness, manage chronic conditions, relieve symptoms, and prevent disease. Today, most people get their medications from pharmacies, but the concept of a pharmacy is not new. The first known pharmacy offered herbs and natural remedies to humans in need in Mesopotamia, around 2500 BC!



Intro



Innovations in Healthcare: Amazon Pharmacy

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While access to healthcare has increased, modern pharmacies still present challenges. Medication errors, long wait times, non-transparent prices, limited hours of operation, and accessibility in rural areas are some of the many issues customers face when trying to fill prescriptions and receive healthcare. This has led to 20-30% of prescriptions not even being picked up!

Mid-Stop Trivia Poll

The first known pharmacies were established in the Middle East around _____ years ago!
A. 75 B. 150 C. 550 D. 1100 **E. 4400** F. 3,000,000



Intro

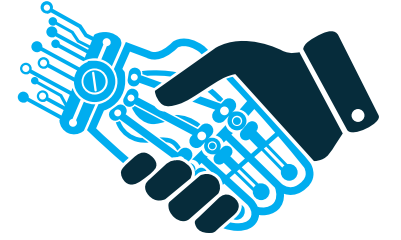
Innovations in Healthcare: Amazon Pharmacy

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Amazon Pharmacy is working to change this through the use of robots and computer science! **Pharmacy** is the science of preparing, standardizing, and dispensing medication to the public. Pharmacists work in pharmacies and help counsel patients on **medication** (a substance used for medical treatment) to get and/or stay healthy.

But how can robots and computers help deliver healthcare to those in need?

On today's tour, we're going to take you on a journey from prescription to delivery to learn how people, robots, and computer science work together to bring safe and affordable medicine to people around the United States.



Intro Standards

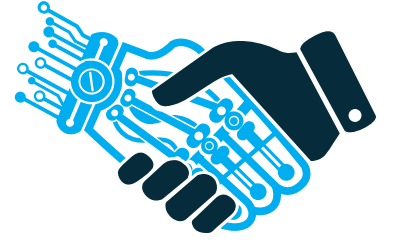
CS Standards

1B-IC-18 Discuss computing technologies that have changed the world, and express how those technologies influence and are influenced by cultural practices.

Concepts: Impacts of Computing

Subconcept: Culture

Practices: Computational Problems



Stop 1

Rx Received

Watch this Tour Stop in: [Video 3](#), [Video 4](#), and [Video 5](#)



Pre-Stop Trivia Poll

How do healthcare providers send their prescriptions to a pharmacy?

- A. by fax machine
- B. over the phone
- C. electronically using computers
- D. All of the answer choices are correct**



Stop 1

Rx Received

Watch this Tour Stop in: [Video 3](#), [Video 4](#), and [Video 5](#)

How does artificial intelligence and machine learning help Amazon Pharmacy receive customer orders?

The fulfillment process begins with receiving a prescription (a written order of what medication a patient needs) from healthcare providers. Doctors prescribe medication for patients and submit them to pharmacies in a variety of ways - directly to the pharmacy electronically, via fax, or by phone. In a typical pharmacy, the pharmacist has to manually type in the prescription to ingest it into the system. Ingestion is the process of obtaining or importing data.

A pharmacy technician types prescriptions delivered via fax or phone, but at Amazon Pharmacy, it's not just people doing the typing – it's computers!



CAREER FOCUS:

Pharmacy Technician



Stop 1

Rx Received

Watch this Tour Stop in: [Video 3](#), [Video 4](#), and [Video 5](#)



Mid-Stop Review Question

True or False: Machine learning uses past examples to make predictions.

A. True B. False

How do they do this? Using artificial intelligence and machine learning! **Artificial intelligence** (technology that can imitate human behavior) allows computers and machines to learn from experiences, adapt to new situations, and perform tasks that are typically done by humans. Machine learning scientists developed code that can receive most prescriptions and retype them. Healthcare providers submit prescriptions to Amazon Pharmacy electronically. Each provider may write prescriptions differently and electronic prescriptions can still make mistakes, so artificial intelligence reduces defects and increases prescription ingestion speed.

CAREER FOCUS:

Applied Scientist



Stop 1

Rx Received

Watch this Tour Stop in: [Video 3](#), [Video 4](#), and [Video 5](#)

As the software receives more and more prescriptions, the software is trained using **machine learning** (The science of getting computers to perform an action based on past examples). To train the machine, healthcare providers submitted prescriptions (input) and people manually typed the prescription into the computer (output). Over 1 million prescription inputs and outputs trained the computer so when it receives an electronic prescription, it knows what the output should read. The more prescriptions the program sees, the better the program will do with its job! If there's a mistake, a pharmacy technician or pharmacist communicates with the machine learning scientists so they can fix the issue the next time the computer sees a similar prescription come through.



CAREER FOCUS:

Applied Scientist



Stop 1

Rx Received

Watch this Tour Stop in: [Video 3](#), [Video 4](#), and [Video 5](#)

For more complex prescriptions, pharmacy technicians manually type them into the system to ensure accuracy. Pharmacists then review each prescription before it can be fulfilled. They review for accuracy, dosage (how much medicine the person needs), and medication interactions.



Review Questions Vocabulary Review

_____ helps take in prescriptions faster by using past examples to train a computer to retype prescriptions correctly.

- A. Ingestion
- B. Hardware
- C. AI and Machine Learning**
- D. Medication

CAREER FOCUS:
Pharmacist



Stop 1

Rx Received

Watch this Tour Stop in: [Video 3](#), [Video 4](#), and [Video 5](#)

But why do pharmacists need to check for medical interactions?

Human bodies are made up of little units called **cells**. Different cells in different parts of the bodies do unique tasks, like keeping the heart beating, lungs breathing, and the brain thinking. Medications carry important messages to the cells in different parts of our body. They come with instructions that tell cells what to do, like stop making us feel sick, or to fight off bad germs.

Sometimes people take multiple medications. Think of it like friends playing on a playground. Some medications play nice together and work together to help the body feel better. But some medications may have bad interactions. When certain medications are taken together, they may 'bump into each other', 'mess up the game', and could cause problems, preventing them from working. And some medications may even change the rules of the game, confusing everyone playing, and changing how other medications work.



CAREER FOCUS:
Pharmacist



Stop 1

Rx Received

Watch this Tour Stop in: [Video 3](#), [Video 4](#), and [Video 5](#)

Medication interaction happens when two or more medications react with each other. Through research, scientists have discovered which medications work together and which medications may have a bad interaction. Pharmacists are medication experts that use a review process to make sure medications can be taken at the same time and won't harm patients.

If there are any bad interactions, pharmacists will work with patients and healthcare providers for a different plan. But if the prescription is good to go, it's passed to the next step: fulfillment.



Review Question

Medication works by telling _____ in the body what to do, like to fight off bad germs.

- A. muscles
- B. cells
- C. hair
- D. pharmacists

CAREER FOCUS:
Pharmacist



Stop 1 Standards

CS Standards

2-CS-02 Design projects that combine hardware and software components to collect and exchange data.

Concepts: Computing Systems

Subconcept: Hardware & Software

Practices: Creating

2-DA-08 Collect data using computational tools and transform the data to make it more useful and reliable.

Concepts: Data & Analysis

Subconcept: Collection Visualization & Transformation

Practices: Testing

Other Education Standards

Cause and effect patterns

Systems and system models

Stability and change

Analyze and interpret data

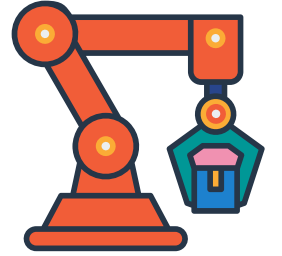
MS-PS1-2 Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred



Stop 2

Fulfillment

Watch this Tour Stop in: [Video 6](#) and [Video 7](#)



Pre-Stop Trivia Poll

The “Unimate,” the first industrial robot introduced in 1961, was used to _____.

- A. perform surgical operations
- B. assemble electronic devices
- C. explore space
- D. build cars**

How do robots and automation support pharmacists in filling customer orders?

After the prescription is received and reviewed, it’s ready to be filled by a pharmacist. In the 1800s, pharmacists would have to make the medicine at pharmacies and distribute it to patients. It wasn’t until the 1920s and the rise of industry that compound medicine was mass produced and shipped pre-manufactured. The pharmacist’s role shifted from making medications to dispensing them and counseling patients.

CAREER FOCUS:
Process Engineer



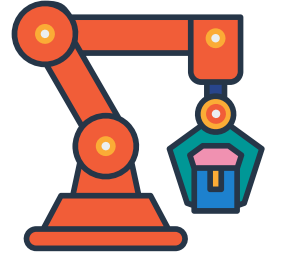
Stop 2

Fulfillment

Watch this Tour Stop in: [Video 6](#) and [Video 7](#)

But what if there were a way for pharmacists to have even more time to help customers get and stay healthy? Through **automation** there is! Automation is the use of machines, robots, or computers to do tasks without needing a person to control them directly. Automation helps make things faster and more efficient while taking away repetitive tasks, such as filling bottles with medications.

At Amazon Pharmacy, robots and humans work together to fill customer prescriptions. For liquid medications, pharmacists and pharmacy technicians fill the bottles or vials. But for other medications, robots do the work! Once a prescription is "ingested" into the system—meaning the data is imported and stored in a database or server—it's ready to be processed accurately and efficiently.



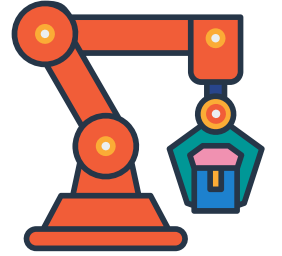
CAREER FOCUS:

Process Engineer



Stop 2

Fulfillment



Watch this Tour Stop in: [Video 6](#) and [Video 7](#)

How does the robot know what to do? An engineer programmed commands! Robots need directions to know what to do. Engineers develop **algorithms** (a set of instructions for a robot or computer to perform) that give the robot step by step instructions on how to take in information, process the information, and fill prescriptions.

Mid-Stop Trivia Poll (Optional)

Which is **NOT** a basic function of a computer?

A. Inputs B. Outputs C. Processing D. **Internet**

Robotics at Amazon Pharmacy have the basic functions of a computer: **inputs, processing, and outputs**. First, pharmacists and pharmacy technicians fill canisters with medications and place them in the robotic dispensing system. The dispensing system can hold 240 unique medications!

CAREER FOCUS:

Process Engineer



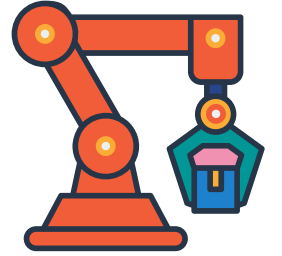
Stop 2

Fulfillment

Watch this Tour Stop in: [Video 6](#) and [Video 7](#)

Prescription information is sent as a data **input** (information that goes into a computer). The computer learns important information, such as how fast the prescription is needed by the patient and how much medicine is needed. The computer **processes** (the thinking a computer does to turn an input into an output) the information, then sends this information as an output (any information that is processed by and sent out from a computing device i.e. text, video, sound, images) to the robotic arm.

The robotic arm then takes an empty vial, and puts it up to the medicine canister to dispense. **Sensors**, hardware that take in information from the environment and respond, keep count of the number of pills or capsules needed. Once the correct amount of medicine is in the vial, the robotic arm puts on a cap. Next, a machine labels the bottle and sends the bottle of medication off to shipping on a conveyor belt.



CAREER FOCUS:

Process Engineer



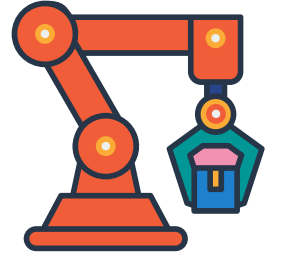
Stop 2

Fulfillment

Watch this Tour Stop in: [Video 6](#) and [Video 7](#)

But won't automation put pharmacists out of a job? In short, the answer is no. Automation at Amazon Pharmacy is built to support pharmacists and pharmacist technicians, but not replace pharmacists. Automation helps pharmacists and pharmacist technicians spend less time on certain tasks, like receiving and entering prescriptions or filling each prescription, and more time to operate at the top of their education, experience, and training. Pharmacists now have more time to review medications and use their judgment on prescriptions as well as help patients get the best possible treatment for their needs.

We'll learn more in the next stop about a very important role pharmacists play after medication is filled and before it's shipped.



Review Question

_____ allows robots to perform tasks that don't require pharmacists, like filling bottles with medication.

- A. Inputs B. Cells C. Prescriptions **D. Automation**

CAREER FOCUS:

Process Engineer



Stop 2 Standards

CS Standards

2-CS-02 Design projects that combine hardware and software components to collect and exchange data. Collecting and exchanging data involves input, output, storage, and processing.

Concepts: Computing Systems

Subconcept: Hardware & Software

Practices: Creating

1B-CS-01 Describe how internal and external parts of computing devices function to form a system.

Concepts: Computing Systems

Subconcept: Devices

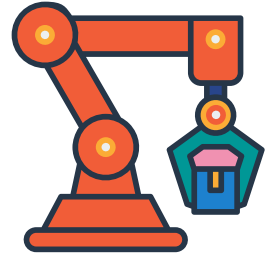
Practices: Communicating

1B-CS-02 Model how computer hardware and software work together as a system to accomplish tasks.

Concepts: Computing Systems

Subconcept: Hardware & Software

Practices: Abstraction



Stop 3

Quality Check and Shipping

Watch this Tour Stop in: [Video 8](#)



Pre-Stop Trivia Poll

How do you think Amazon uses computer science to check the accuracy of prescriptions before shipping them out?

A. Computers and sensors takes pictures and automatically check the images.

B. It doesn't - every prescription is ONLY checked by a pharmacist.

C. Robots dump every bottle out and count pills one by one.

How does computer vision help Amazon Pharmacy perform quality control and keep customers safe?

After the bottle of medication is output, it's time for a quality check using machine learning.

Quality control is a process used to ensure that a product or service is free from error. Taking the wrong meds can have drastic negative consequences, so it's important that medication is checked.

CAREER FOCUS:
Pharmacist



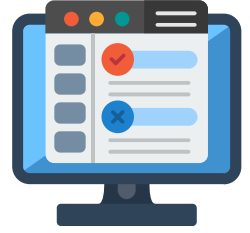
Stop 3

Quality Check and Shipping

Watch this Tour Stop in: [Video 8](#)

How is quality control performed? Using machine learning and people! While one robot fills prescriptions, another robot checks the packets using **computer vision** (artificial intelligence that interprets information from images, videos, and other inputs). The robot is trained using model images of each medicine. After a prescription is filled, the robot captures images of the medication in the filled prescription. This image compared to the model images. If the captured image matches the model image, then it gets approved. If it doesn't match the prescription, a pharmacist checks the prescription to see if something is missing or the next steps that must be taken.

Human verification of prescriptions will always be needed to ensure people receive the right medicine and that the medication is safe to take. Pharmacy will never be 100% automated, there will always be a need for a pharmacist and pharmacist technicians.



CAREER FOCUS:
Pharmacist



Stop 3

Quality Check and Shipping

Watch this Tour Stop in: [Video 8](#)



Review Question

What is the main goal of **quality control** in Amazon Pharmacy?

- A. Make robots fill bottles faster
- B. Ensure accuracy and safety of filled prescriptions**
- C. Reduce medication options
- D. Give pharmacists breaks

CAREER FOCUS:
Pharmacist



Stop 3

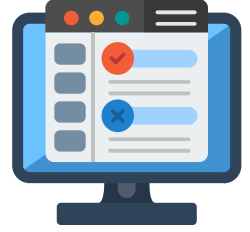
Quality Check and Shipping

Watch this Tour Stop in: [Video 9](#)

Most orders are delivered just like regular Amazon packages and are delivered to customers within two days. But what if someone needs their medication right away or the same day? In some locations, Amazon is able to complete same-day delivery using **sustainable** (operating without depleting Earth's resources and harming the environment) delivery methods. Electric vehicles are used to deliver packages to patients in local communities the same day the prescription is filled. In other areas, electric bicycles help deliver customer orders sustainably and efficiently within a few hours of the prescription being received. Amazon is constantly innovating and finding new ways to get customers the medications they need faster and with sustainability in mind.



Stop 3 Standards



CS Standards

1B-CS-02 Model how computer hardware and software work together as a system to accomplish tasks.

Concepts: Computing Systems

Subconcept: Hardware & Software

Practices: Abstraction

2-CS-02 Design projects that combine hardware and software components to collect and exchange data.

Concepts: Computing Systems

Subconcept: Hardware & Software

Practices: Creating

3A-IC-24 Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices.

Concepts: Impacts of Computing

Subconcept: Culture

Practices: Inclusion

Other Education Standards

3-5 ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

5-ESS3-1 Earth and Human Activity

Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.



Career Poll



Poll

Of the careers you saw today, which interests you most?

- A. Applied Scientist
- B. Pharmacist
- C. Pharmacy Technician
- D. Process Engineer

Rate your overall tour experience on a scale of 1-5

- 1 - Extremely Unsatisfactory
- 2 - Unsatisfactory
- 3 - Neither Unsatisfactory or Satisfactory
- 4 - Satisfactory
- 5 - Extremely Satisfactory

How interested are you in pursuing careers in technology?

- 1 - Very uninterested
- 2 - Uninterested
- 3 - Neither interested nor uninterested
- 4 - Interested
- 5 - Very interested

How did this tour affect your interest in pursuing careers in technology?

- 1 - Decreased
- 2 - No change
- 3 - Increased

Do you agree or disagree with the following statement: I feel like I belong in careers in technology.

- 1 - Strongly Disagree
- 2 - Disagree
- 3 - Neither Agree nor Disagree
- 4 - Agree
- 5 - Strongly Agree



Stop 4

Conclusion

Watch this Tour Stop in: [Video 10](#)

Why is it important that pharmacists and technologists work together?

Amazon Pharmacy is working with engineers to bring customers their medications quickly so they can get healthy and stay healthy. Artificial intelligence and machine learning can both help with prescription ingestion and quality control. Automation supports pharmacists by completing tasks that machines can do, so pharmacists are able to operate at the top of their licenses and help counsel patients or conduct research. Even though machines can support pharmacists by doing some of the work, people are still required to ensure customers are receiving the correct medication and that it is safe for people to take. Amazon Pharmacy is an example of how people AND machines can work together.



CS & NGSS Standards

1B-IC-18 Discuss computing technologies that have changed the world, and express how those technologies influence, and are influenced by, cultural practices.

Concepts: Impacts of Computing

Subconcept: Culture

Practices: Computational Problems

3A-IC-24 Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices.

Concepts: Impacts of Computing

Subconcept: Culture

Practices: Inclusion



Rapid Fire Review



Review

Pharmacists check for _____ to make sure medications are safe and work well together.

- A. ingestion
- B. medication interactions**
- C. artificial intelligence
- D. computer vision

Hardware called _____ count each pill and let the robot know when the right amount is filled.

- A. sensors**
- B. pharmacists
- C. inputs
- D. cells

After a computer receives an information input, it must _____ the data to know what to do next.

- A. output
- B. control
- C. process**
- D. automate



Rapid Fire Review



Review

Machine learning helps Pharmacy Technicians _____ prescriptions by correctly retyping prescriptions into the system.

- A. ingest
- B. output
- C. ship
- D. algorithm

Software engineers write instructions called _____ that tell robots what to do, like fill bottles with the correct medication.

- A. algorithms
- B. outputs
- C. sensors
- D. automation

