

# Unit 3: Arrays, Recursion and Complexity

Content Area: **Business**  
Course(s): **Java**  
Time Period: **2nd Marking Period**  
Length: **Weeks**  
Status: **Published**

## Unit Overview

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Introduction to arrays, looping through arrays and declaring arrays. Advanced classes, variables, methods, inheritance and abstract classes. Advanced operations on strings, searching and sorting. Recursion, complexity analysis, binary search and quicksort.

## Transfer

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Students will be able to independently use their learning to...

-What kinds of long term, independent accomplishments are desired?

Use arrays, demonstrate looping through arrays and declare arrays.

Used advanced operations on strings, like searching, sorting, insertion and removal.

Demonstrate knowledge of recursion.

## Meaning

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## Understandings

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Students will understand that...

-What specifically do you want students to understand?

-What inferences should they make/grasp/realize?

Construct complex Boolean expressions using logical operators.

Construct truth tables for Boolean expressions.

Understand the logic of nested if statements and test.

Construct nested loops.

Create appropriate test cases for if statements and loops.

Describe the various phases of program construction.

Design and implement a simple class from user requirements.

Organize a program in terms of a view class and a model class.

Use visibility methods visible to clients and restrict access to data within a class.

Write appropriate mutator methods visible and restrict access to data within a class.

Understand how parameters transmit data to methods.

Use instance variables, local variables and parameters appropriately.

Organize a complex task in terms of helper methods.

Use this reference in their program.

Explain the difference between primitive and reference types.

Define the scope and lifetime of various variables.

## **Essential Questions**

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Students will keep considering...

What thought provoking questions will foster inquiry, meaning making and transfer?

What is an array and how do you manipulate arrays with loops?

What is the role of Java interfaces in a software system?

How do you reuse code through inheritance?

What are the different search methods?

What are the different sort methods?

How do you use ArrayList class?

What is recursion and how is it used?

What is complex analysis and how is it used?

How is quicksort used?

## **Application of Knowledge and Skill**

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### **Students will know...**

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Students will know...

What facts and basic concepts should students know and be able to recall?

Arrays are collections of similar items or elements and ordered by position and are used when a program needs to manipulate many similar items.

Arrays are objects and must be instantiated.

An array can be passed to a method as a parameter and returned as a value.

Class variables provide storage for data that all instances of a class can access but do not have to own separately.

An interface specifies a set of methods that implementing classes must include.

Polymorphism and inheritance provide a means of reducing the amount of code that must be written servers and learned by clients in a system with a large number of cooperating classes.

Error handling can be distributed among methods and classes by using preconditions, postconditions and exceptions.

A linear search is simple search method that works well for small and medium-sized arrays.

A binary search is a clever search method that works well for large arrays but assumes that the elements are sorted.

Comparisons of objects are accomplished by implementing the comparable interface and the compareTo method.

Selection sort, bubble sort and insertion sort are simple sort methods that work well for small and medium-sized arrays.

Insertions and removals of elements at arbitrary positions are complex operations that require careful design and implementation.

One can insert objects of any class into an array of Object.

A recursive method is a method that calls itself to solve a problem.

Some recursive methods also combine the results of earlier calls to produce a complete solution.

The run-time behavior of an algorithm can be expressed in terms of big-O notation.

The different orders of complexity are constant, linear, quadratic and exponential.

quicksort is a sort algorithm that uses recursion and can perform much more efficiently than selection sort, bubble sort or insertion sort.

## **Students will be skilled at...**

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Students will be skilled at...

What discrete skills and processes should students be able to use?

Simple array manipulations and methods.

Looping through arrays and declaring arrays.

Using parallel and two-dimensional arrays.

Knowing when to include class (static) variables and methods in a class.

Reusing code through inheritance.

Using advanced operations on strings.

Writing methods for searching and sorting arrays.

Using java.util.ArrayList class.

Implementing a recursive method to solve a problem.

Using complex analysis of an algorithm and binary search.

Using quicksort.

## **Academic Vocabulary**

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array element index initializer list logical size multidimensional array one-dimensional array parallel arrays physical size ragged array range bound error subscript two-dimensional array abstract class abstract method class method class variable concrete class final method inheritance interface overriding postcondition precondition binary search bubble sort immutable object insertion sort linear search modal selection sort substring wrapper class

## **Learning Goal 1**

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Explain the mechanisms of declaring arrays and basic algorithms for manipulating them.

## **Target 1**

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SWBAT write programs that handle collections of similar items.

TECH.8.1.12.A	Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.
TECH.8.1.12.B	Creativity and Innovation: Students demonstrate creative thinking, construct knowledge and develop innovative products and process using technology.
TECH.8.2.12.E.3	Use a programming language to solve problems or accomplish a task (e.g., robotic functions, website designs, applications, and games).
TECH.8.2.12.E.CS1	Computational thinking and computer programming as tools used in design and

engineering.

## Target 2

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SWBAT declare array variables, instantiate array objects and manipulate arrays with loops.

TECH.8.1.12.A	Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.
TECH.8.1.12.B	Creativity and Innovation: Students demonstrate creative thinking, construct knowledge and develop innovative products and process using technology.
TECH.8.2.12.E.3	Use a programming language to solve problems or accomplish a task (e.g., robotic functions, website designs, applications, and games).
TECH.8.2.12.E.CS1	Computational thinking and computer programming as tools used in design and engineering.

## Target 3

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SWBAT write methods to manipulate arrays and create parallel arrays and two-dimensional arrays.

TECH.8.1.12.A	Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.
TECH.8.1.12.B	Creativity and Innovation: Students demonstrate creative thinking, construct knowledge and develop innovative products and process using technology.
TECH.8.2.12.E.3	Use a programming language to solve problems or accomplish a task (e.g., robotic functions, website designs, applications, and games).
TECH.8.2.12.E.CS1	Computational thinking and computer programming as tools used in design and engineering.

## Learning Goal 2

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Explore the power of object-oriented programming which comes from its capacity to reduce code and to distribute responsibilities for such things as error handling.

## Target 1

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SWBAT know when it's appropriate to include class variables and methods in a class.

TECH.8.1.12.A	Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.
TECH.8.1.12.B	Creativity and Innovation: Students demonstrate creative thinking, construct knowledge and develop innovative products and process using technology.
TECH.8.2.12.E.3	Use a programming language to solve problems or accomplish a task (e.g., robotic functions, website designs, applications, and games).
TECH.8.2.12.E.CS1	Computational thinking and computer programming as tools used in design and engineering.

## **Target 2**

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SWBAT understand the use of inheritance by extending a class.

TECH.8.1.12.A	Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.
TECH.8.1.12.B	Creativity and Innovation: Students demonstrate creative thinking, construct knowledge and develop innovative products and process using technology.
TECH.8.2.12.E.3	Use a programming language to solve problems or accomplish a task (e.g., robotic functions, website designs, applications, and games).
TECH.8.2.12.E.CS1	Computational thinking and computer programming as tools used in design and engineering.

## **Target 3**

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SWBAT understand the use of polymorphism and know how to override methods in a superclass.

TECH.8.1.12.A	Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.
TECH.8.1.12.B	Creativity and Innovation: Students demonstrate creative thinking, construct knowledge and develop innovative products and process using technology.
TECH.8.2.12.E.3	Use a programming language to solve problems or accomplish a task (e.g., robotic functions, website designs, applications, and games).
TECH.8.2.12.E.CS1	Computational thinking and computer programming as tools used in design and engineering.

## **Target 4**

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SWBAT place variables and methods of a set of classes in an abstract class.

TECH.8.1.12.A	Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.
TECH.8.1.12.B	Creativity and Innovation: Students demonstrate creative thinking, construct knowledge and develop innovative products and process using technology.
TECH.8.2.12.E.3	Use a programming language to solve problems or accomplish a task (e.g., robotic functions, website designs, applications, and games).
TECH.8.2.12.E.CS1	Computational thinking and computer programming as tools used in design and engineering.

## Learning Goal 3

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Explore more complex operations on arrays, such as searching, sorting, insertions and removals.

### Target 1

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SWBAT use string methods appropriately and write a method for searching an array.

TECH.8.1.12.A	Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.
TECH.8.1.12.B	Creativity and Innovation: Students demonstrate creative thinking, construct knowledge and develop innovative products and process using technology.
TECH.8.2.12.E.3	Use a programming language to solve problems or accomplish a task (e.g., robotic functions, website designs, applications, and games).
TECH.8.2.12.E.CS1	Computational thinking and computer programming as tools used in design and engineering.

### Target 2

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SWBAT write a method to sort an array and understand why a sorted array can be searched more efficiently than an unsorted array.

TECH.8.1.12.A	Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.
TECH.8.1.12.B	Creativity and Innovation: Students demonstrate creative thinking, construct knowledge and develop innovative products and process using technology.
TECH.8.2.12.E.3	Use a programming language to solve problems or accomplish a task (e.g., robotic functions, website designs, applications, and games).



TECH.8.2.12.E.CS1

Computational thinking and computer programming as tools used in design and engineering.

### **Target 3**

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SWBAT write methods to perform insertions and removals at a given positions in an array.

TECH.8.1.12.A

Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.

TECH.8.1.12.B

Creativity and Innovation: Students demonstrate creative thinking, construct knowledge and develop innovative products and process using technology.

TECH.8.2.12.E.3

Use a programming language to solve problems or accomplish a task (e.g., robotic functions, website designs, applications, and games).

TECH.8.2.12.E.CS1

Computational thinking and computer programming as tools used in design and engineering.

### **Target 4**

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SWBAT understand the issues involved when working with arrays of objects.

TECH.8.1.12.A

Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.

TECH.8.1.12.B

Creativity and Innovation: Students demonstrate creative thinking, construct knowledge and develop innovative products and process using technology.

TECH.8.2.12.E.3

Use a programming language to solve problems or accomplish a task (e.g., robotic functions, website designs, applications, and games).

TECH.8.2.12.E.CS1

Computational thinking and computer programming as tools used in design and engineering.

### **Learning Goal 4**

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Explore recursion, complexity and searching and sorting.

### **Target 2**

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SWBAT understand the similarities and differences between recursive and iterative solutions of a problem.

TECH.8.1.12.A	Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.
TECH.8.1.12.B	Creativity and Innovation: Students demonstrate creative thinking, construct knowledge and develop innovative products and process using technology.
TECH.8.2.12.E.3	Use a programming language to solve problems or accomplish a task (e.g., robotic functions, website designs, applications, and games).
TECH.8.2.12.E.CS1	Computational thinking and computer programming as tools used in design and engineering.

### **Target 3**

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SWBAT check and test a recursive method and understand how a computer executes a recursive method.

TECH.8.1.12.A	Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.
TECH.8.1.12.B	Creativity and Innovation: Students demonstrate creative thinking, construct knowledge and develop innovative products and process using technology.
TECH.8.2.12.E.3	Use a programming language to solve problems or accomplish a task (e.g., robotic functions, website designs, applications, and games).
TECH.8.2.12.E.CS1	Computational thinking and computer programming as tools used in design and engineering.

### **Target 4**

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SWBAT recognize some typical orders of complexity and understand the behavior of a complex sort algorithm.

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TECH.8.1.12.B	Creativity and Innovation: Students demonstrate creative thinking, construct knowledge and develop innovative products and process using technology.
TECH.8.2.12.E.3	Use a programming language to solve problems or accomplish a task (e.g., robotic functions, website designs, applications, and games).
TECH.8.2.12.E.CS1	Computational thinking and computer programming as tools used in design and engineering.

### **Summative Assessment**

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Unit assessment, project based assessments, tests and quizzes.

## **21st Century Life and Careers**

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CRP.K-12.CRP2.1

Career-ready individuals readily access and use the knowledge and skills acquired through experience and education to be more productive. They make connections between abstract concepts with real-world applications, and they make correct insights about when it is appropriate to apply the use of an academic skill in a workplace situation.

CRP.K-12.CRP6.1

Career-ready individuals regularly think of ideas that solve problems in new and different ways, and they contribute those ideas in a useful and productive manner to improve their organization. They can consider unconventional ideas and suggestions as solutions to issues, tasks or problems, and they discern which ideas and suggestions will add greatest value. They seek new methods, practices, and ideas from a variety of sources and seek to apply those ideas to their own workplace. They take action on their ideas and understand how to bring innovation to an organization.

## **Formative Assessment and Performance Opportunities**

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Oral question & answer discussion, in-class observation, written exercises, classwork & homework assignments, power point w/ notes, projects, portfolios, quizzes and tests.

## **Accommodations/Modifications**

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Extra Review and Modified Quiz - See Attached Documents

All instruction, labs, activities, and assessments will be modified and enhanced to adhere to individual student's IEPs and 504s. As well differentiated classroom management strategies will be utilized as to adhere to these students individual plans as well.

## **Unit Resources**

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Computer, textbook, supplemental textbook materials, Internet resources, teacher generated power points & notes and lab materials.

- Computer Work Station
- Internet Resources
- Lab Materials
- Supplemental Textbook Materials
- Teacher Created Power Point

- Textbook

## **Interdisciplinary Connections**

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MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.4	Model with mathematics.
LA.RST.11-12.3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
LA.RST.11-12.9	Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
LA.WHST.11-12.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.