

# Seeing Structure in Expressions

## Information Technology Project



## CAREER IMMERSION: Database Architect

### Occupation Description:

Design strategies for enterprise databases, data warehouse systems, and multidimensional networks. Set standards for database operations, programming, query processes, and security. Model, design, and construct large relational databases or data warehouses. Create and optimize data models for warehouse infrastructure and workflow. Integrate new systems with existing warehouse structure and refine system performance and functionality.

### Activities/Tasks:

- Design databases to support business applications, ensuring system scalability, security, performance, and reliability.
- Develop database architectural strategies at the modeling, design, and implementation stages to address business or industry requirements.
- Collaborate with system architects, software architects, design analysts, and others to understand business or industry requirements.
- Develop data models for applications, metadata tables, views, or related database structures.
- Set up database clusters, backup, or recovery processes.

### Who tends to like this job?

People in this role are interested in occupations that are:

- **Investigative:** These occupations can involve searching for facts and figuring out problems mentally.
- **Conventional:** These occupations frequently involve following set procedures and routines.
- **Enterprising:** These occupations frequently involve starting up and carrying out projects.

*Want to discover more interests? Take the Interest Matcher!*

People in this role value:

- **Achievement:** Occupations that satisfy this work value are results oriented and allow employees to use their strongest abilities, giving them a feeling of accomplishment.
- **Working Conditions:** Occupations that satisfy this work value offer job security and good working conditions.
- **Independence:** Occupations that satisfy this work value allow employees to work on their own and make decisions.

*Want to discover more values? Take the Value Matcher!*



## Math Concepts

- Write, read, and evaluate expressions in which letters stand for numbers.
- Interpret expressions that represent a quantity in terms of its context.
- Interpret parts of an expression, such as terms, factors, and coefficients.
- Interpret complicated expressions by viewing one or more of their parts as a single entity. *For example, interpret  $P(1+r)n$  as the product of  $P$  and a factor not depending on  $P$ .*
- Solve real-world and mathematical problems involving area.

## Career Vocabulary

Review the following vocabulary terms related to the career. The students will be using them as they complete their project.

**Database** A structured set of data held in a computer, especially one that is accessible in various ways.

**Database Management System (DBMS)** A software system that facilitates the organization of housed data into a particular architecture.

**Select Query** A request for data from a database. For example, if the database stores data for students in a class and their extracurricular involvement, a query could ask for all the students that play a spring sport and the database would display only those students. Writing a select query involves three steps in a query wizard or in the design view of a database:

1. Choose the tables or queries that you want to use as sources of data. In this example, we would want to select students from a table of all the students in the class.
2. Specify the fields that you want to include from the data sources. In this example, we might say we would like to know the names and phone numbers of the students.
3. Optionally, we could specify criteria to limit the records that the query returns. In this example, we could limit our returns to varsity spring sport participants.

**Action Query** A request for a database to change, delete, append (make a query within a query), update, or create a new table with a subset of the data from another one. For example, an insurance company who offers a safe driving incentive could query their database of customers for those that have not had any tickets or accidents and update their account balances to include the incentive money. Action queries are often irreversible, so it is important to be careful when setting them up and to back up your files before “running” the query. To make an action query, follow these steps:

1. Run a select query to isolate the data that needs to be changed in some way.
2. Select the specific type of action query you want to run.
3. Fill in the fields to describe what you want to adjust.
4. When you are confident that everything is set up appropriately, click "run."

**Entity** A table that is part of a database.

## Class Discussion

Before talking about the vocabulary, talk about the function of databases in our lives. Everywhere we go, someone wants to collect data about us and use it to sell us things or for some other reason. Give some of the following examples and ask students to try to think of others.

- *Online streaming services* – organize and collect data about your viewing preferences (select query sample: animated movies)
- *Sports* – fantasy sports leagues organize data about players and teams, updating it constantly (select query sample: injured list)
- *Social gaming* – collect and serve data about other players to each other (select query sample: high score list)
- *Social media* – data about who you are friends with and what businesses you like is recorded and used to recommend other friends, products, and topics to you (select query sample: photos you are tagged in)
- *Ecommerce* – every online organization that sells products uses databases to organize products, pricing, customer information, and purchase history (select query sample: products below \$20)
- *Healthcare* – doctor's offices store your health records in extensive databases often accessible through an online portal (select query example: test results)
- *Weather* – weather organizations collect and store all types of data to analyze and predict weather (select query sample: hour by hour prediction)
- *Government* – the government has an interest in keeping data on everyone for research, defense, voting districts, and more (select query sample: registered voters between the ages of 18 and 24)

Now that you have convinced the students how important databases are, ask them what the chances are that they may interface with a database in their future career. Emphasize the value of being able to design such a database. Get the students excited about having a basic introduction to database design.

Then, talk through the vocabulary (included below). Talk about who has the power to make action queries for the databases described above. Most databases we access as public citizens will only offer us the ability to make select queries or append queries (queries within queries). Healthcare databases would allow a person to update his or her own contact information, but not much more. Some streaming services allow parents to apply parental controls. These would be examples of action queries.

Ask the students to brainstorm select queries they might make in the listed databases.

**Encourage your students to research Database Architects in the P2C Career Library to learn more!**

## Teaching Support

### Suggested Pacing

*Recommended implementation after P2C Algebra I, chapter 1.*

**Day 1:** Introduce the career and have students begin working on Part I.

**Day 2:** Students complete work on Part I, getting feedback/help as needed.

**Days 3 – 5:** Students complete Part II.

**Day 6:** Students present their projects.

### Prior Knowledge Required to Successfully Complete the Project

- Understand units and their importance in real world problems (**Chapter 1**).
- Interpret expressions that represent a quantity in terms of its context (**Chapter 1**).
- Interpret parts of expressions such as terms, factors, and coefficients in terms of its context (**Chapter 1**).
- Evaluate expressions (**previous grades**).

### Differentiation to Meet Diverse Needs

#### For struggling students:

- Check and help the students correct their work on Part I before moving on to Part II.
- If students struggle with the portfolio building stage (Part I), have them review and practice lessons 1.6 (Algebraic Expressions), 1.7 (Writing and Simplifying Algebraic Expressions), and 1.8 (Structure of Expressions)
- Encourage the students to choose the project topic with whose formulas they feel most comfortable working.
- Put struggling students with a “mentor” who can help.

**For advanced students:**

- Challenge the students to make a second table with additional information or formulas. Maybe they could explore a different shape for rooms/gardens or gardens that only need to be fenced in on 3 sides.
- Challenge the students to try to use a spreadsheet program like Excel and figure out how to get the computer to do the calculations for them.
- If students would like to create a different type of table than the four provided, encourage their creativity! As long as they include the required elements of the project, let them go for it!

**Grouping**

- Part I of the project is best completed individually to confirm that students have the necessary skills to complete Part II. Students may be grouped in pairs or trios and encouraged to compare answers and check each other's work, but ultimately be assessed on what they submit individually.
- Parts II and III should be completed and presented as a small group (pairs or trios).
- In grouping the students, consideration should be given to struggling students and advanced students. No group should be made up entirely of students who struggle to grasp the content. Additionally, if there are several students whose understanding is significantly advanced, allowing them to work together in their own group may encourage them to take on more challenges and go further with their design.

**Technology**

- Students can make the table in any word processing program. They may need access to the internet to get instructions about design choices they may want to employ. Advanced students may like to try to use a spreadsheet program like Excel, but it is not necessary for this project.
- To share their tables with the class, it may be necessary to have an electronic copy to project. If that is not possible, make copies for students to examine during the presentation.

## Part I: Build Your Portfolio (KEY)

To demonstrate your skills as a database architect for potential clients, you must put together a portfolio to showcase your skills. Consider the following scenario and answer the questions to hone your skills and showcase your knowledge.

### Scenario A

Gary owns a custom pool installation business. He builds many different sizes of pools and wants to figure out his cost for materials to build the pool and fill it with the necessary water and chemicals. He knows that the surface materials he needs will only be for the bottoms and sides of the rectangular prism, so he can represent the surface area formula as  $S = lw + 2lh + 2wh$  where  $l$ ,  $h$ , and  $w$  are length, height, and width, respectively. Also, he knows that the depth of the water will be a foot less than the height of the pool, so the volume of the pool will be given by  $V = l \times w \times (h - 1)$ . Further, he knows that the water and chemicals cost \$0.40 per cubic foot and the surface building materials cost about \$12 per square foot. Additionally, a permit for building a pool will cost \$200 regardless of the size of the pool. Consider the table his database architect built for him below.

Pool Model	Height (ft)	Width (ft)	Length (ft)	Rectangular Volume to Fill (cu ft)	Cost of Water and Chemicals/cubic foot (\$0.40/cu ft)	Rectangular Surface to Build	Surface Material Cost (\$12/sq ft)	Materials/Permit Cost
Mathematical Representation	$h$	$w$	$l$	$V = l \times w \times (h - 1)$	$C_1 = 0.4V$	$S = lw + 2lh + 2wh$	$C_2 = 12S$	$M = 0.4V + 12S + 200$
Model 1	7	12	24	1728	\$691.20	792	\$9,504.00	\$10,395.20
Model 2	7	15	30	2700	\$1,080.00	1080	\$12,960.00	\$14,240.00
Model 3	7	16	32	3072	\$1,228.80	1184	\$14,208.00	\$15,636.80
Model 4	6	12	24	1440	\$576.00	720	\$8,640.00	\$9,416.00
Model 5	6	15	30	2250	\$900.00	990	\$11,880.00	\$12,980.00
Model 6	6	16	32	2560	\$1,024.00	1088	\$13,056.00	\$14,280.00

Notice that each column of the table can be represented with a single variable, and some can also be represented by an expression using variables from columns to the left. Never will a column require a variable that has not yet been introduced.

**Sample Select Query:** "Pools with a volume less than 2,000 cubic feet" would yield Model 1 and Model 4

**Sample Action Query:** "Update Materials/Permit Cost column to include a new permit cost of \$250. Replace  $M = 0.4V + 12S + 200$  with  $M = 0.4V + 12S + 250$ ."

1. Which columns can only be represented by a single variable? Height ( $h$ ), width ( $w$ ), and length ( $l$ )
2. What constant do you see in formula for the materials/permit cost? Explain the difference between a constant and a variable in an expression or formula. 200; A constant will remain the same while the variables may change from row to row in the table.
3. Why is 1 subtracted from the height in the formula for the volume of the rectangular pool? The volume is being used to calculate how much water to put into the pool, and the depth of the water will be 1 foot less than the height of the pool.
4. What is another way to write the expression for the fillable volume of the pool? Confirm that your formula works by checking it with the data from two rows in the table and seeing if the volume you find is the same as the volume shown.
 
$$V = lwh - lw$$

$$V = (24)(12)(7) - (24)(12) = 1728 \checkmark$$

$$V = (30)(15)(7) - (30)(15) = 2700 \checkmark$$
5. How many terms are there in the expression for the surface area of the pool? What are they? 3;  $w, 2lh$ , and  $2wh$
6. What are the coefficients for the terms in the expression for the surface area? 1, 2, and 2
7. What is another way to write the expression for the surface area of the pool? Confirm that your formula works by checking it with the data from two rows in the table and seeing if the surface area you find is the same as the surface area that is shown.
 
$$S = lw + 2h(l + w)$$

$$S = (24)(12) + 2(7)(24 + 12) = 288 + 14(36) = 792 \checkmark$$

$$S = (30)(15) + 2(7)(30 + 15) = 450 + 14(45) = 1080 \checkmark$$
8. What are the two terms of the expression representing the total materials cost? What does each represent in the context of the pool business?  $0.4V$  represents the cost of water and chemicals to fill the pool and  $12S$  represents the cost of the materials to build the pool.
9. Given that the cost of the water and chemicals and the materials to build the surface are included in the total materials cost, why might the database architect have isolated them as separate columns, too? Answers will vary. Sample: it might be helpful for Gary to know what the breakdown of the cost is in case a client wishes to show the client how a change in the cost of materials affects different components of the cost.
10. In a table for a database, different columns may contain different types of numbers. What difference do you see between columns in this table? How would you classify the contents of the cells? Three of the columns are currency and include a dollar sign in each cell, while the others are whole numbers.

11. Thinking about pools, what other information might be useful for Gary to track for his business? What other tables might he include in his database? **Answers will vary. Sample: Gary might want to also think about offering to build a pool deck and would then need to calculate area and cost of materials for that. Also, he could consider offering circular pools which would require different measurements and formulas for determining volume and surface area.**
12. Suppose Gary has a client that is on a tight budget, so he enters a select query to isolate pool models with material costs less than \$12,000. What models would the database display? **Models 1 and 4**
13. Consider what would happen to Gary's costs if the price of materials for building the surface of the pool changes from \$12 to \$13 . Which columns would be affected by an action query adjusting the values to reflect this change? **The last two columns would be changed.**
14. Describe a select query you could run based on this table and the results it would yield. **Answers will vary. Sample: "Volume to fill of more than 2,500 cubic feet" yields models 2, 3, and 6.**
15. Describe an action query you could run based on the table and describe which columns or rows would be affected. **Answers will vary. Sample: "Update Volume Column with formula  $V = l \times w \times (h - 0.5)$ " allows the water to come within 6 inches of the top of pool. This will, in turn, change the 6<sup>th</sup> and 10<sup>th</sup> columns.**



## Project Scoring Rubrics

Your project will be scored using the following:

Part I: Build Your Portfolio				
Scenario A	0	0.5	1	Teacher comments:
Question 1				
Question 2				
Question 3				
Question 4				
Question 5				
Question 6				
Question 7				
Question 8				
Question 9				
Question 10				
Question 11				
Question 12				
Question 13				
Question 14				
Question 15				
<b>Total: _____ / 15</b> Overall comments:				

## Part II: Design Your Plan

Criteria	0	0.5	1	Teacher comments:
A title.				
A top row describing the contents of each column in words.				
Unit labels included as appropriate.				
A second row with a mathematical representation for the contents of the column.				
At least 6 rows of realistic data with varying values for the variables of interest.				
At least two different types of numbers.				
The table is clear, attractive, and understandable.				
Explanations	0	0.5	1	Teacher comments:
Question 1				
Question 2				
Question 3				
Question 4				
Question 5				
Question 6				
Question 7				
Question 8				
<b>Total: _____ / 15</b> Overall comments:				

### Part III: Present Your Plan

Criteria for Presentation	0	0.5	1	Teacher comments:
Which columns represent data that must be collected and entered?				
Which columns/cells will be important values of interest to the client in decision making?				
Discuss some of your ideas for queries the client might have.				
Overall Presentation	0	0.5	1	Teacher comments:
Presents the table with clarity and enthusiasm.				
Listens actively to other presentations.				
<b>Total: _____ / 5</b> Overall comments:				